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ORIGINAL MEMOIRS.

TRANSFUSION BY CARREL'S END-TO-END SUTURE METHOD.

WITH REPORT OF CASES.

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THE interest in direct transfusion of blood, aroused in the last few years chiefly by the work of Crile, has centred upon efforts to develop an easy and reliable method of forming the anastomosis. All of the numerous methods which have been advocated are really modifications of one of four procedures, namely: end-to-end suture—Carrel; approximation by apparatus—Crile, Elsberg, Soresi, Levin; vessel interlocking by end or lateral implantation—Hartwell; interposition of a foreign body link—Brewer, Frank.

A detailed discussion of these cannot be given here. Time and experience alone can prove which of the methods is the best. Careful reports of efforts at transfusion should be encouraged, so that sufficient wealth of material may accumulate to lead to definite conclusions.

Series of cases in which the various methods have been

employed are most instructive, and it is for this reason that we report twelve transfusions which have been made by the Carrel method of end-to-end suture. The therapeutic indications for transfusion likewise present a fertile field for physiological and surgical research, but we do not feel that our experience has been sufficient to warrant elaborate discussion of this phase of the subject.

The technic as initiated by Carrel is as follows: A donor free from advanced arteriosclerosis and giving no history or signs of syphilis is chosen. Hæmolytic and agglutination tests with the two bloods may be carried out if circumstances permit, but the necessity for and value of these tests are undecided.

A radial artery of the donor and a vein of the arm or leg of the recipient are the vessels of selection. One-half per cent. novocaine is used as the local anæsthetic. Adrenalin must not be combined with the novocaine on account of its constricting action on the vessels. In addition to the usual dissecting instruments, two small thumb forceps, several serrefine clamps of varying strength covered with rubber tubing to avoid injury to the vessel wall, fine Chinese silk, No. 16 Kirby needles, a rubber bulb with a small irrigating tip, and vaseline are required for the operation. The radial artery above the wrist is exposed. This dissection is facilitated by having the wrist extended over a sand bag. The deep fascia is exposed and opened upon a grooved director passed beneath it through a small hole. In freeing the artery a sharp knife is used so as to make a clean dissection, and contact of instruments with the vessel is avoided as it may stimulate contraction of the muscular coats. About three inches of the artery and from three to four inches of the vein are exposed and freed. After absolute hæmostasis is established, the branches of the vessels being ligated at some distance from the main trunks, the limbs of the donor and recipient are brought into juxtaposition and loosely bound together to prevent tension on the anastomosis by movements of the patients. Serrefine clamps of suitable strength are applied centrally on each vessel,

and ligatures distally. The vessels are cut across with sharp straight scissors about one-eighth of an inch from the ligatures. The blood is quickly stripped from them, after which they are washed clean with physiological salt solution by means of a fine glass tip with smooth end attached to a rubber bulb syringe. The entire wound, especially the cut ends of the vessels, is covered with vaseline. This prevents clotting on the injured intima if any blood should escape, and is an important step in the technic. The adventitial coat of each vessel is grasped between the thumb and forefinger, drawn over the vessel end, and severed with sharp scissors; it then retracts so that it cannot be included in the suture. To facilitate the handling of the white suture material, black silk towels cover the entire field with the exception of the ends of the vessels.

The ends are approximated and held together by three retention sutures of the finest Chinese silk, which divide the circumference into three equal parts. Each of these parts is successively put upon the stretch by traction on the retention sutures, and a continuous suture is thus easily run around the whole circumference, care being exercised that each stitch avoids the adventitia but includes the media and intima at a uniform distance from the cut edge. The intimæ of the two vessels are thus slightly everted and brought into contiguity. Three or four stitches are sufficient along each side of the triangle. The needle and thread of one of the retention sutures, preferably that tied last, is used for the entire circuit, a single knot being made with each retention suture as it is reached. After the completion of the suture, the anastomosis is gently surrounded by a small piece of hot moist gauze, the serrefines are removed, and the blood is allowed to flow from the donor into the patient. If there be any leakage it is usually quickly checked by the gauze. If a point bleeds persistently, as in two of our cases, a stitch may be added easily and effectively while compressing the artery between thumb and finger, when slight release of pressure demonstrates the site of the leak.

If the vessels have been roughly handled or have been seized by the dissecting forceps, small constriction nodes appear, which markedly retard the flow. These may disappear after the application of very warm salt solution.

An argument in favor of the Carrel suture is that the anastomosis is not guarded by a rigid mechanical device, and can, therefore, be rolled and massaged with the rest of the exposed parts of the two vessels, if the flow appears too slow. Such stripping between the well-vaselined fingers has in our experience tended to keep the vessels dilated, thus permitting a full stream of blood. Another favorable feature of the Carrel method is that the calibre of the vessels is not diminished, and extreme dilatation at the site of the anastomosis is possible because the line of suture is on the stretch during the anastomosis. The strain is divided among many stitches, which, though frail in themselves, allow any reasonable amount of rough handling when combined. The absence of apparatus also prevents obscuring of the site of anastomosis so that any twisting of the vessels is at once apparent and can be easily corrected.

Although the median cephalic or median basilic veins may be used in adults, in infants and in children the saphenous or femoral veins are more favorable for transfusion. The position of the saphenous vein is definite, its length is sufficient, and there is no danger of injury to important structures or to the circulation of the limb; its calibre alone is questionable. In infants and young children it is too small. It seems wise, however, to examine it before exposing the femoral vein. The depth of the vein in the subcutaneous fat may cause some delay in locating it in the small subject, unless its anatomical position is definitely borne in mind. It can be readily exposed by abducting the thigh to about 65° and rotating it outward and making the incision in a line passing from slightly external to the spine of the pubes to the inner aspect of the popliteal space at the flexure of the knee. This lower limit corresponds to the posterior margin of the inner condyle of the femur. On cutting through the subcutaneous fat the

FIG. 1.

Incision for exposure of internal saphenous vein in thigh.

FIG. 2

Internal saphenous vein exposed.

vein is found close to the deep fascia (Figs. 1 and 2). In several of our adult patients we have used the saphenous vein near the ankle.

In one case where the median basilic vein was used, it was noticed that blood flowed far more freely from the cut end of the vein after the transfusion was finished (viz., three drachms in fifteen seconds), than could have been possible during the operation. There must, therefore, have been considerable resistance in the vein. This resistance can be diminished by elevating the limb of the donor, and in Transfusion VIII this was attempted. The saphenous vein was considerably larger than the artery, and subsequently the distal inch of the latter dilated to the size of the vein. The flow was so free that pulsation could always be felt and for the most part seen in the whole of the exposed vein. The donor lay on a high operating table; after the vessels had been exposed the recipient was placed on a stretcher at right angles to the donor with her feet on the table against his chest, her head being considerably lower so that she was inclined about 45°. With the donor's arm abducted 90° it brought the vessels together in a favorable position for the operation. The inclined position seemed to facilitate the flow by diminishing resistance in the veins. It must be borne in mind that in this position overdistention of the heart is more likely to occur.

The physiological effect of the transfusion should be noted at frequent intervals by testing the hæmoglobin, pulse, and blood-pressure. The area of cardiac dulness should be frequently mapped out, and the stethoscope freely used to detect any inability of the heart to cope with the increase in the volume of blood. Finally, considerable information as to the mechanical success of the anastomosis can be obtained by testing the blood stream through the anastomosis at the completion of the transfusion by cutting the vein and measuring the flow before ligating the artery, or by severing a communicating venous branch during the transfusion. The blood, as a rule, spurts from this as though it were a branch of the artery itself.

During the past year we have used the Carrel method twelve times in ten patients, one patient being transfused three times. The cases were secondary anæmias with the exception of Case I, which was gas poisoning, and Case V, general septicæmia. The immediate results of the transfusions were good in all except Cases V and XII. In Case V the heart was not equal to the increased burden. In Case XII the hæmoglobin did not rise, although it was shown later that the lumen was satisfactory and there was no thrombosis; on the second attempt the anastomosis was partly obstructed by a small valve-like thrombus, and free hemorrhage from the ulcerated cirsoid aneurism offset the benefit from the limited amount of blood which passed. Cases II, VII, X, and XI were in almost moribund condition and were markedly improved by the operation, apparently owing their lives to the transfusion. They are all now in good health.

CASE I.—*Illuminating gas poisoning. Hypostatic pneumonia.*

C. B., New York Hospital, Medical History No. 18007. Age 52. Houseworker. Admitted February 22. Died March 1, 1909. Service of Dr. Peabody.

The patient was found by the ambulance surgeon in a room in which illuminating gas was escaping. She was comatose. Pulse was rapid and extremely feeble. Respirations were four to six per minute when she was brought to the hospital.

Physical Examination.—Fairly well-nourished woman, apparently moribund. Pupils dilated and react only slightly to light. Well-marked slow nystagmus. Tongue swollen, congested, and purplish in color. Pharynx congested and contains frothy mucus. Radial pulse almost imperceptible. Neck not stiff. Heart: slightly enlarged, sounds very distant and weak, no murmurs. Lungs: breath sounds feeble, no dulness, and no râles.

Direct transfusion was decided upon. A female patient in the accident ward, who had just recovered from an attack of acute alcoholism, offered her blood and the operation was immediately performed. The left radial of the donor was anastomosed to the median cephalic vein of the right arm of the

recipient. The blood was allowed to flow for forty minutes, the vein pulsating all of the time. The patient showed the most marked improvement. Her respirations increased from 5 to 24 per minute. The pulse became full and of a good quality. She, however, did not regain consciousness. A phlebotomy was likewise performed, 34 ounces of blood being withdrawn.

During the ensuing week phlebotomy was done several times, and salt solution per rectum and hypodermic stimulation were given. The day after the transfusion the patient's hæmoglobin was 90 per cent., white blood-cells 26,000, polymorphonuclears 90 per cent. There was albumin in the urine.

The patient gradually developed a hypostatic pneumonia and died without regaining consciousness on the seventh day after admission. Her respirations varied during this time between 24 and 44, pulse rate between 76 and 120.

In regard to the treatment of illuminating gas poisoning by transfusion, the case shows that at least astonishing temporary effects may follow transfusion. The patient was resuscitated from a moribund condition, the respirations and heart action quickly became normal and remained so for several days. The red cells of the donor must have become carriers of oxygen. In this respect the clinical findings were similar to those obtained by Crile in experiments on dogs. If the degree of poisoning is such as to cause cerebral softening, permanent benefit cannot be expected.

CASE II.[1]—*Secondary anæmia—hæmophilia?*

G. M., New York Hospital, Medical History No. 18851. Age two years, 11 months. American. Service of Dr. Conner. Transferred to service of Dr. P. R. Bolton.

Family History.—No history of tuberculosis, neoplasm, syphilis, nor hæmophilia in the family of either parent. There is one older and one younger child, neither of whom has shown the slightest tendency to bleed easily.

Past History.—The patient is the second child; normal, uneventful delivery. Walked at nine months. Has had none of the diseases of childhood. While teething she had slight intestinal trouble but quickly recovered. When two years old

[1] Presented before the Surgical Section of The New York Academy of Medicine, April 1, 1910.

it was noticed that the slightest bruise left an extensive area of discoloration. Five months ago she began to have nose-bleed, which sometimes occurred in her sleep. Four months ago she fell, lacerating the upper part of her scalp. Wound was sutured by an ambulance surgeon. That night the wound began to bleed profusely, and she was taken to the House of Relief where the hemorrhage was controlled by deep sutures. The entire upper part of her face became ecchymotic.

Several severe attacks of epistaxis occurred during the following month which were controlled only after great loss of blood. She was readmitted to the House of Relief August 5, with epistaxis and weakness. August 8, red blood-cells 2,300,000, white blood-cells 18,200, polymorphonuclears 44 per cent., small mononuclears 40 per cent., transitionals and large mononuclears 16 per cent., hæmoglobin 30 per cent.

August 12: She was infused with 100 c.c. of artificial serum. This was followed by a severe chill and by a rise in temperature to 105.2°. The epistaxis which had been almost continuous was checked.

August 14: Red blood-cells 2,180,000, white blood-cells 16,500, polymorphonuclears 26 per cent., small mononuclears 71 per cent., transitionals 2 per cent., large mononuclears 1 per cent., hæmoglobin 25 per cent. No more epistaxis while in hospital. Temperature ranged between 98° and 100°. Urine was normal.

She was transferred to New York Hospital and from there to a Convalescent Home.

October 2: She was brought back to New York Hospital with persistent epistaxis. Physical examination negative excepting for epistaxis, rapid pulse, and ecchymotic spots scattered over the body. Urine negative. Nares were packed with gauze saturated with adrenalin solution, but bleeding was not controlled.

October 4: Red blood-cells 2,300,000, polymorphonuclears 63 per cent., large mononuclears 10 per cent., small mononuclears 16 per cent., transitionals 16 per cent., eosinophiles 3 per cent., basophiles 1 per cent., hæmoglobin 14 per cent., slight polychromatophilia and poikilocytosis. She was infused with 200 c.c. of artificial serum. No further bleeding for 32 hours, when she began to have profuse uncontrollable hemorrhage from the nose which almost exsanguinated her.

October 5: Transfused. Radial artery of the father was sutured to the saphenous vein of the child by the Carrel end-to-end method of anastomosis. Blood began to flow immediately but there was no visible effect on the child for 12 minutes, after which the capillaries in the conjunctivæ and ears became visible, and soon there came a tinge of pink in the child's lips and her hands became warm. At the end of 55 minutes the transfusion was stopped, the child was rosy and warm, lips red, pulse 160 and of good quality. Slight epistaxis of dark red blood began but soon ceased. Hæmoglobin readings taken every 10 minutes showed a steady rise from 14 per cent. to 68 per cent. The general condition of the patient greatly improved. The next day the hæmoglobin was 95 per cent.

Recovery was uneventful excepting for a slight bronchopneumonia of short duration and some epistaxis and vaginal bleeding. Very slight bleeding occurred twice during the following week, and once a petechial rash appeared on the face after the child strained at stool.

Discharged October 29. Cured. Hæmoglobin 89 per cent.

January 28, 1910: Patient was brought to the hospital. She had just recovered from chicken-pox of the hemorrhagic type. Small black and blue marks were present over the whole body. She had had several hemorrhages, but her condition and color were excellent.

Case III.—*Secondary anæmia. Carcinoma of stomach(?).*

M. Q., History Number 3409, age 41, single, housekeeper. Admitted to French Hospital, July 23, 1909. Discharged Aug. 12, 1909.

Chief complaint, pain in epigastrium, vomiting, and general weakness.

One year ago the patient began to vomit about ten minutes after taking food. The vomiting was preceded by slight nausea and was not accompanied by pain. It continued for about six months and was independent of the character of the food taken. She lost considerable flesh and became weak. She never vomited blood. For the last six months she has had pain in the epigastrium, especially after eating. The patient enjoyed good health until the present illness.

On admission the woman appeared markedly emaciated, the skin and mucous membranes were very pale. Nothing noteworthy

was found on further physical examination. Gastric analysis: quantity extracted one hour after Ewald test meal 30 c.c.; color light tan; large amount of mucus; no free blood. Free acid, none, lactic acid, moderate amount.

White blood-cells 11,000, polymorphonuclears 65 per cent., small lymphocytes 11 per cent., large lymphocytes 16 per cent., basophiles 2 per cent., eosinophiles 6 per cent., hæmoglobin 30 per cent., red blood-cells 2,210,000.

Carcinoma of the stomach was suspected. Since obstructive symptoms were not prominent, as she had ceased vomiting, it seemed wise to do an exploratory laparotomy only if her condition could be improved sufficiently to warrant a resection if this should prove indicated. On August 6, 1909, the patient was transfused. Considerable improvement resulted, but the patient decided to defer operation.

Anastomosis completed and transfusion begun at 1.15 P.M., August 6, and was terminated at 2.10 P.M. Hæmoglobin rose from 30 to 44 per cent.

After transfusion August 6 (7 P.M.), red blood-cells 3,800,000; hæmoglobin 40 per cent.

Aug. 7 (10 A.M.) red blood-cells 4,000,000; hæmoglobin 50%
Aug. 7 (7 P.M.) red blood-cells 4,400,000; hæmoglobin 55%
Aug. 9 (10 A.M.) red blood-cells 4,600,000; hæmoglobin 45%

The patient left the hospital and was told to report for examination later which she failed to do. On March 25, she died at home. No autopsy. It is said by the family physician that for four months she was in fair condition; that during the last three and a half months she failed rapidly, vomited constantly, and had severe epigastric pains.

CASE IV.—*Secondary anæmia, biliary fistula, multiple hemorrhages, senility.*

P. F., French Hospital, History Number 3546, French, age 80, admitted September 21, 1909. Died October 14, 1909.

Chief complaint, swelling and pain in inner part of the left thigh.

History.—Seven days ago patient noticed a swelling in the above mentioned region, which gradually increased. There is severe pain at site of swelling, radiating from femoral region to the knee. He is unable to stand. There is no history of

trauma. Appetite good, bowels regular, urinates three to four times daily and two or three times at night. Two days ago he says he vomited a cupful of blood.

Never had similar trouble before. Two years ago patient was operated upon for gall-stones, and the wound never closed. Has had a right inguinal hernia for 30 years. Denies urethritis and syphilis.

Physical Examination.—The scrotum, penis, and inner and posterior surface of the left thigh to the knee are ecchymotic. There is a globular swelling below Poupart's ligament on the left thigh about three inches in diameter. It is tense and tender on pressure, flat on percussion, and has no bruit. Over most of the ecchymotic area there is induration which does not pit on pressure.

The man is thin and anæmic; the arterial walls are thickened. There are a few crepitant râles and dulness at right apex in front. In the scar of gall-bladder operation there is a fistula discharging bile very freely. Just above Poupart's ligament on the left side there is a small reducible inguinal hernia. He is unable to move his left leg.

On September 23, 1909, an incision was made over the swelling on inner part of thigh; it proved to be a hæmatoma. Blood oozed intermittently from the wound. Horse serum was administered subcutaneously on three successive days without effect. There was no fever at any time; cultures of fluid from hæmatoma were sterile. Blood examination October 11, hæmoglobin 18 per cent., red blood-cells 1,856,000, blood-pressure 94 mm.

The patient was transfused on October 12, 1909; anastomosis completed and flow begun at 11.47 A.M.; flow discontinued at 12.50 P.M. Hæmoglobin rose from 18 per cent. to 39 per cent.

After transfusion: October 12 (7 P.M.) hæmoglobin 48 per cent., red blood-cells 2,380,000, blood-pressure 112 mm.

October 13 (10 A.M.) hæmoglobin 50 per cent., red blood-cells 2,900,000, blood-pressure 110 mm.

October 14, the patient had a profuse rectal hemorrhage, and died soon afterwards. No autopsy.

CASE V.—*Septic endocarditis. Septicæmia.*

A. R., New York Hospital, Medical History No. 18344.

Age 22. Milliner. Austrian. Admitted March 13, 1909. Service of Drs. Conner and Lambert. Died September 30, 1909.

Past History.—Has had no previous acute illness. No history of joint symptoms, nor sore throat. When ten years old a swelling in her neck was first noticed and she thinks that it has not grown larger since then. Thinks eyes have never been bulging; she has been nervous and excitable, and frequently has had palpitation of the heart.

Uses beer and wine moderately. Usually constipated.

No history of syphilis or gonorrhœa.

Present illness began two months ago with headache, and sharp pains in legs but not in the joints. This was soon followed by anorexia, nausea, and sharp pain over the whole abdomen which came on immediately after eating and lasted from one to two hours. At times swallowing was difficult, and she vomited sour smelling fluid which had never to her knowledge contained blood. Has had occasional sticking pains over her heart and for some time constant severe pain in the left side of abdomen.

Recently has had chilly feelings and night-sweats. No cough nor difficulty in breathing. No urinary symptoms, swelling of feet, or ankles. Has not been jaundiced. Complains of feeling very tired and weak.

Physical Examination.—Fairly well-nourished girl. Skin and mucous membranes good color. Eyes normal. Tongue moist, coated. Pharynx normal. Neck not stiff. Slight enlargement of the thyroid but no thrill nor bruit present. Diastolic pulsation is present in large veins. Systolic murmur in carotids. Pulses equal, regular, good size and force, moderate tension, Corrigan in type. Vessels not sclerosed. Capillary pulse in nails. Heart is enlarged, gallop rhythm, prolonged rather rough diastolic murmur over aortic area. Second pulmonic accentuated. No thrills felt. Lungs normal. Abdomen soft, not tympanitic. No masses. Liver tender on percussion, normal in size. Spleen not enlarged. Kidneys not palpated. Extremities, knee-jerks greatly diminished. No œdema. No enlargement of the superficial lymph-nodes. Temperature 101.8°, respirations 24, pulse 120. Urine examination shows absence of sugar and albumin. Hæmoglobin 66 per cent., leucocytes 9000, polymorphonuclears 79 per cent., lymphocytes 21 per cent.

Blood culture taken on May 18 showed a pure culture of streptococcus. On the third day after admission she developed a systolic murmur at the apex, and on the fifth day petechial spots appeared on the front and back of chest. Abdomen became very tender and rigid. May 22 she began to receive a vaccine made from the organism obtained from her blood.

In spite of all treatment with different varieties of homologous vaccines and the usual therapeutic measures, the disease ran its course with typical waves of improvement alternating with periods of exacerbation, the up-and-down septic temperature, enlarged spleen, nephritis, petechiæ, etc.

Her brother, a healthy young man, consented to be the donor for a transfusion. He was prepared by vaccination with the vaccine made by Dr. Elser, pathologist to the New York Hospital, from the streptococcus of her blood, the purpose being to produce antibodies in his blood antagonistic to that organism.

September 11, 1909. Transfusion. Service of Dr. Bolton. Several ounces of blood were first drawn from the patient's veins. The radial artery of the donor was then sutured to the left internal saphenous vein of the recipient. The anastomosis was perfect; blood flowed freely and apparently at a good volume. After ten minutes the patient became restless, irrational, cyanosed, her pulse rapid and irregular, and respirations rapid and almost stertorous. It seemed extremely dangerous to continue, so the transfusion was immediately stopped. She was stimulated by hypodermic injections and in a few hours she had recovered fairly well.

During the next week the patient developed general œdema. Showers of emboli, causing pain in the internal organs, and petechiæ continued, and the patient's asthenia became marked. She died on the nineteenth day after transfusion, after an illness of almost eight months. No autopsy.

CASE VI.—*Secondary anæmia following puerperal septicæmia.*

V. M., French Hospital, History Number 3665, married, age 30, Italian, housewife. Admitted October 22, 1909, discharged December 3, 1909.

For the last seven weeks, patient has complained of pain in left side of abdomen and back, pain is severe in character and radiates over lower part of abdomen. Urinates somewhat too

frequently, bowels irregular, appetite poor. She has lost considerable weight and feels very weak.

Was operated upon elsewhere, on August 31, 1909, for "puerperal septicæmia." The operator sends the following details: "Temperature 105°, pulse 130, respirations 30 before the operation. There was a large intramural abscess on the left side, extending into broad ligament and including left tube and ovary. The sigmoid was included in adhesions and slightly eroded. Patient's condition permitted only a rapid laparotomy and drainage. Fecal fistula appeared on fourth day. After operation and for some days subsequently, the pulse ran from 136 to 128. Temperature 104° to 100° and respirations 60 to 30."

Physical Examination.—Patient is very feeble, pale, and emaciated. Heart negative. There are a few sibilant râles at the right apex. Abdomen: There is a wound about three inches long in the left lower quadrant of the abdomen discharging pus and fæces. The entire abdomen is tender to palpation, especially on the left side where a mass is indefinitely felt. By vagina extensive induration is appreciable in the left side of pelvis. There is a profuse purulent vaginal discharge.

Urine: Turbid, flocculent precipitate, specific gravity 1026, acid, albumin present, considerable pus and amorphous urates. Blood examination on October 24, hæmoglobin 30 per cent.; red blood-cells 2,384,000; white blood-cells 8500; polymorphonuclears 74 per cent.; small lymphocytes 20 per cent.; large lymphocytes 3 per cent.; basophiles 2 per cent.; eosinophiles 1 per cent.

The patient's condition was so poor that a transfusion was done in the hope of making her better able to stand an operation. Improvement was marked and operation was repeatedly deferred.

Transfusion, October 25, 1909. Anastomosis completed and flow begun at 11.07 A.M.; flow discontinued at 11.58 A.M.

	Time	Recipient
Blood-pressure (systolic)	10.00 A.M.	110 mm.
	11.20 A.M.	124 mm.
	11.40 A.M.	115 mm.[a]
	12.00 M.	150 mm.

[a] At this sudden fall in blood-pressure apex of heart had moved ½ inch to left; volume of flow was diminished for five minutes and heart gradually resumed its normal outlines.

	Time	Recipient
Pulse	10.00 A.M.	108
	10.30 A.M.	104
	11.00 A.M.	96
	11.30 A.M.	92
	12.00 M.	84
	12.15 P.M.	88
Hæmoglobin	10.00 A.M.	34 per cent.
	11.15 A.M.	45 per cent.
	11.40 A.M.	47 per cent.
	12.00 M.	50 per cent.
	12.15 P.M.	50 per cent.

After cutting vein, three drachms of blood flowed in fifteen seconds.

Oct. 25 (8 P.M.): Hæmoglobin 54 per cent.; red blood-cells 3,608,000; bood-pressure 119 mm. Improvement continued steadily until Nov. 1, when hæmoglobin was 62 per cent.; red blood-cells 4,600,000; from the 1st to the 20th there was a steady fall; November 20, hæmoglobin 42 per cent.; red blood-cells 3,300,000. No operation was performed, and at the time of her discharge the fecal fistula was almost closed, the pelvic and abdominal masses had greatly diminished, and her general condition was so good that she was able to return at once to her household duties.

TRANSFUSIONS VII, VIII, and IX.[3]—*Anæmia* (transfused three times).

M. T., French Hospital, Admission Number 15,399, age 43, French, married, housewife. Admitted December 29, 1909.

Present History.—Onset, 14 days ago, began with violent headache, pain in back, over heart, and in epigastrium, and extreme weakness; a day later slight jaundice appeared; she has been confined to bed since onset.

Previous History.—In 1896 patient had menorrhagia for which she was curetted; in 1900 she was operated upon for an abscess on the left side of thorax; in 1902 she had rheumatism which confined her to bed one month. She has had at times a distressing cough and dyspnœa for a number of

[3] Presented before the New York Surgical Society, May, 1910. We are indebted to Dr. Shanley, house surgeon of the French Hospital, for the records of the cases at that institution.

years, also palpitation on the slightest exertion, but no night-sweats, chills, or fever; she has had œdema of legs for nine years, gradually increasing to date; also frontal headaches, worse at night and throbbing in character, spots before the eyes, vertigo, and tinnitus for the past three or four years. Gives no history pointing either to gonorrhœa or syphilis. For past two years patient has been under severe mental strain. Eighteen months ago she began to lose her color, the pallor has gradually increased. Menses began at fourteen years and were regular until 25 years of age, since then they have been profuse much of the time, lasting five to eight days, and making her very weak for some time following. The menorrhagia has been especially marked recently. Married at twenty-five; two children living and well; no miscarriages. Habits good.

Physical Examination on Admission.—Woman of medium size, apathetic, and aroused with difficulty. Face expressionless, mucous membranes colorless, lips dry, parched, and brown, conjunctivæ slightly yellow, skin has a lemon tint and is bloodless, superficial veins show conspicuously as dark blue lines. Radial pulse not palpable, heart sounds very feeble. The woman appears moribund. Blood examination shows 600,000 red blood-cells and 16 per cent. hæmoglobin. Urine, December 29, 1909: turbid, amber, flocculent precipitate, specific gravity 1016, acid, no sugar, moderate amount of albumin, numerous epithelial and red blood-cells, few white blood-cells, many hyaline and granular casts.

Transfusion was immediately done, taking the husband as donor, although he was weak and anæmic. There was moderate improvement. The next day a second transfusion was made, taking a young man as donor. Marked improvement resulted. Cheeks became flushed, lips of a normal color. The recipient, however, became extremely restless and it was necessary to stop. Afterwards she became delirious and two days later showed extreme jaundice.

The third transfusion was done ten days later, as the patient's blood and general condition had begun to show a marked change for the worse. A healthy young man was used as the donor. Considerable and prolonged improvement resulted.

Record of *first transfusion*, December 29, 1909:

Before transfusion, red blood-cells 600,000, hæmoglobin 16 per cent., blood-pressure 100 mm.

Flow begun at 1.21 P.M., discontinued at 2.15 P.M.

		Donor	Recipient
Blood-pressure.....	Beginning..	130	99
	End.....	119	128
Pulse.....	Beginning..	88	128
	End.....	92	122
Hæmoglobin.....	Beginning..	71 per ct.	16 per ct.
	End.....	57 per ct.	22 per ct.
Red blood-cells.....	Beginning..	3,600,000	600,000
	End.....	2,700,000	928,000

December 29, 7 P.M.: Red blood-cells 1,008,000, hæmoglobin 21 per cent., white blood-cells 42,000, polymorphonuclears 69 per cent., small lymphocytes 16 per cent., large lymphocytes 13 per cent., basophiles 2 per cent., megaloblasts 5 per cent., normoblasts 7 per cent., marked poikilocytosis, numerous umbilicated red cells. Stools negative for ova, occult blood, etc.

Second transfusion, December 30, 1909. Transfusion flow begun at 5.03 P.M., discontinued at 6.11 P.M.

After transfusion vein was cut and in 14 seconds there flowed 110 minims.

		Donor	Recipient
Blood-pressure.....	Beginning..	128	111
	End.....	100	136
Pulse.....	Beginning..	82	120
	End.....	124	104
Hæmoglobin.....	Beginning..	81 per ct.	19 per ct.
	End.....	65 per ct.	33 per ct.
Red blood-cells.....	Beginning..	4,100,000	1,015,000
	End.....	3,018,000	1,952,000

Subsequent to transfusion: December 31, 7 P.M.: Red blood-cells 2,288,000, hæmoglobin 35 per cent., white blood-cells 18,700, polymorphonuclears 72 per cent., small lymphocytes 8 per cent., basophiles 1 per cent., normoblasts 6 per cent., megaloblasts 3 per cent., marked poikilocytosis and numerous umbilicated red cells.

January 9: Red blood-cells 1,236,000, hæmoglobin 25 per

cent., white blood-cells 11,900; otherwise the counts taken each day were about the same as that last given.

Third transfusion, January 10, 1910. Flow begun at 6.16 P.M., stopped at 6.55 P.M.

		Donor	Recipient
Blood-pressure	Beginning	120	92
	End	102	125
Pulse	Beginning	72	136
	End	92	120
Hæmoglobin	Beginning	100 per ct.	23 per ct.
	End	94 per ct.	56 per ct.
Red blood-cells	Beginning	5,150,000	1,184,000
	End	3,746,000	1,386,000

After this the patient did fairly well, although she developed a pneumonia in lower right base and later pleurisy with effusion on left side. This made necessary repeated tappings (10 in all), at times 20–30 ounces of clear or blood-tinged fluid being removed.

March 5: Von Pirquet test negative.

March 13: Patient has been up for some days, can walk, has fair appetite, and feels well. Urine occasionally shows trace of albumin. Red blood-cells 2,624,000, hæmoglobin 70 per cent.; the blood is otherwise normal.

May 7: Patient in good condition, hæmoglobin 70 per cent.; red blood-cells 3,150,000.[4]

CASE X.—*Papilloma of bladder. Excision. Secondary anæmia.*

J. S., the Post-Graduate Hospital, service of the late Dr. Follen Cabot. Male, age 34 years. Admitted January 20, 1910.

Chief complaint, pain in left side of abdomen and bloody urine.

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[4] The cause of the anæmia in this case could not be definitely determined.

Dr. N. B. Potter, who supervised the treatment much of the time, wrote, "Her blood picture has not been one of typical pernicious anæmia; how much, however, it has been altered by the transfusions no one can say. Very grave anæmia with a persistently high color index is as near as I can get."

Dr. F. C. Wood wrote, "I would not like to make a positive diagnosis of pernicious anæmia on the smears, but would prefer to call the condition a secondary anæmia."

Past History.—Has had several previous attacks of hæmaturia, otherwise the history is unimportant.

Present Illness.—Blood appeared in the urine nine days ago and has been steadily increasing in amount since. There has been pain in the left lumbar region and in the end of the penis during urination. Patient has had great difficulty in urinating during the past three days.

Physical Examination.—Patient is a large, well-nourished Italian, showing nothing abnormal on external examination excepting extreme pallor. Specimen of urine contains almost pure blood.

Operation by Dr. Cabot, January 21. Suprapubic cystotomy. Excision of papilloma of the bladder. Rubber drainage tube left in the bladder. Operation begun with eucaine local anæsthesia and completed under nitrous oxide gas anæsthesia. Duration, one hour. General condition of patient very poor. Pulse weak and rapid after the operation.

Five and a half hours after the operation the patient was comatose and practically moribund. Hæmoglobin 34 per cent., red blood-cells 1,500,000, pulse 156 per minute.

Transfusion was performed by one of us (R. D. McC.) with the assistance of Dr. Aspinwall Judd. The donor was a brother and of only about two-thirds the stature of the patient. The right radial artery of the donor was anastomosed to the left internal saphenous of the recipient. The vessels were exposed and anastomosed in 28 minutes. The blood was allowed to flow 40 minutes.

The following table was made during the operation. At 5.30 P.M. flow of blood started.

	Hæmoglobin	Pulse
5.40 P.M.	36 per cent.	132
5.45 P.M.	42 per cent.	126
5.50 P.M.	53 per cent.	126
5.55 P.M.	54 per cent.	126
6.00 P.M.	58 per cent.	126
6.05 P.M.	62 per cent.	126
6.10 P.M.	62 per cent.	126

Transfusion ended, 6.10 P.M.

The patient's general condition and color underwent marked improvement during the transfusion. The transfusion would have been continued but the donor began to show the effect of

the loss of blood. He became very pale, restless, and nauseated. Eight P.M., the same day, hæmoglobin 64 per cent., pulse 140.

January 22, 10 A.M.: Red blood-cells, 3,320,000, hæmoglobin 76 per cent. General condition is greatly improved and patient is mentally much brighter.

January 26: Red blood-cells 3,170,000, hæmoglobin 71 per cent.

February 11: Red blood-cells 3,616,000, hæmoglobin 75 per cent (Talquist).

All of the previous readings had been taken with the Dare hæmoglobinometer. March 3d. Red blood-cells 4,112,000, hæmoglobin 75 per cent. (Talquist). The condition of the patient is good and he is ready to leave the hospital.

CASE XI.[3]—*Infected fibroid of uterus. Suppurative metritis. Multiple metastatic abscesses of thigh. Pyæmia.*

New York Hospital, service of Dr. Bolton. Surgical History No. 38,247, Mrs. J., 35 years, admitted August 3, discharged November 4, 1909.

Past History.—Has always been strong and healthy. Menstruation began at seventeen years of age, regular, every five weeks, not painful. Married at twenty-one. First three pregnancies terminated successfully.

Present Illness.—On July 7 patient had a miscarriage and stated that it was not induced. Her last period had been in May. Following the miscarriage she had persistent bleeding and the discharge soon became very foul. She had chills and a high fever. She became so ill that she did not remember much about the early part of her sickness. Her physician gave her intra-uterine douches. Bleeding soon stopped, but she continued in a very serious condition and was brought to the hospital.

Physical Examination.—Patient is an extremely anæmic woman. She is weak and appears septic. Head: face and mucous membranes are almost bloodless. Tongue is slightly coated, teeth are very bad. Heart percusses normal. Sounds are distant and weak and there is a systolic murmur at apex, transmitted toward axilla, not well heard in back. Lungs:

[3] Presented before the Surgical Section of The New York Academy of Medicine, April 1, 1910.

normal. Abdomen: not distended or tender. Just above the symphysis and to the right of midline, there is a slight rounded prominence. On palpation it is found to be firm and freely movable. There is a slight resistance above the limit of this mass.

Vaginal Examination.—Outlet normal for multipara. Marked discharge of pus. The cervix is large and soft. The external os is dilated and emits a profuse discharge of pus. Bimanual examination reveals a large, firm, elastic, fairly movable mass without fluctuation extending upward from the right side of the uterus. Tubes and ovaries are indefinitely palpable.

Temperature 102°, pulse 124, respiration 28. Hæmoglobin 30 per cent., leucocytes 40,000, polymorphonuclears 84 per cent., mononuclears 13 per cent., transitionals 3 per cent. The red cells show considerable poikilocytosis. No nucleated reds found.

The general condition of the patient was such that it was thought she could not stand an operation. She did not improve under treatment but became weaker. October 9 her white blood-cells numbered 16,000, and her temperature reached 104.8°.

A brother willing to give his blood offered himself and a transfusion was decided upon. Patient's hæmoglobin was now 18 per cent.

August 10: Transfusion was unsuccessfully attempted by others by Hartwell's implantation method, with a Crile cannula and by suture. Clotting occurred in the first two attempts, considerable hemorrhage in the last, which was not controlled until a clot had formed.

August 11: Transfusion was performed following Carrel's technic of end-to-end blood-vessel suture. The right radial of the donor and the right internal saphenous vein of the patient were prepared under local novocaine anæsthesia. Anastomosis was easily made. There was slight bleeding at the line of union, but this quickly stopped without further suture. Pulsations were palpable in the vein. The calibre of the vein remained small for about fifteen minutes, when the vessel began slowly to dilate and the blood flowed more freely. The hæmoglobin rose gradually but with a marked acceleration toward the end of the operation, from 18 to 40 per cent. The transfusion was stopped when the donor became restless and vomited several times. The patient's mental condition had improved.

Her lips at the beginning were colorless, but were now red and her cheeks had gained a healthy pink.

The anastomosis was opened and found perfectly patent. No thrombosis. The afternoon of the transfusion a dull curettage was done and some tissue and considerable pus were brought away. Uterine irrigation given. The pathologist reported the specimen to be well-preserved muscle tissue. For a few days the condition of the patient was excellent, but soon she became weaker and her hæmoglobin dropped within six days to 18 per cent., the same as before transfusion. Spectroscopic examination failed to reveal a trace of bile or blood pigments in urine. On August 15 her general condition was about the same as before transfusion. The mass in the lower abdomen was markedly diminished in size, and there was an absence of tenderness and rigidity in lower abdomen. White blood count, 24,000, polymorphonuclears 84 per cent., red blood-cells 1,800,000, temperature ranged around 101°. Transfusion wounds healed.

The following abstracts from the bedside notes outline the subsequent course.

August 17: General condition is very much improved. She takes food by mouth and retains nutrient enemata. She feels much stronger. Discharge from vagina remains profuse with extremely unpleasant odor. Small necrotic mass expelled from uterus. Uterine tumor much decreased in size.

August 29: Very slight uterine discharge. Uterus is now small, fairly firm, and movable. Mass is no longer felt in its wall. Cervix normal. Hæmoglobin is rapidly rising. Yesterday she had two chills, followed by elevation of temperature to 105°, accompanied by severe nausea and vomiting.

September 12: Hæmoglobin 50 per cent. Patient feels stronger and looks better, though she has had numerous chills with sudden rises and falls of temperature during the last few days.

September 29: Pain has persisted in the right thigh and calf. There is slight swelling with some fluctuation and increased surface temperature on inner side of right thigh just above the knees. She has been having chills and considerable fever.

September 30: Incision made over inner side of right thigh and a considerable quantity of pus evacuated. Drainage.

October 8: A few petechiæ have appeared on chest, arms, and back. Daily rise of temperature and frequent chills persist. The petechiæ followed an attack yesterday in which she complained of a peculiar sensation over entire body, and pain in back which lasted about six minutes. Over bases of both lungs are subcrepitant râles and a few râles are present anteriorly. No pain over spleen or kidney regions. Patient vomits frequently and vomitus contains bile. Sinus is discharging freely. Pathologist reports original culture from thigh sterile. Hæmoglobin has gone down to 45 per cent. Blood cultures continue negative.

October 15: Temperature has been normal for two days, and she feels much better and is taking more food. Sinus is healing slowly. She is now receiving dead staphylococci injections with no local or general reaction.

October 23: Gaining in strength daily. Has had no rise of temperature for five days. Is now taking food of from 1800 to 2200 calories value daily as advised by Dr. Conner.

October 31: Is now able to walk with assistance. Hæmoglobin 53 per cent.

November 4: General condition good. No pain, fever, or chills. Is gaining in weight and is able to walk alone. Pelvic examination negative. Uterus normal in size and there is no discharge. No tenderness on palpation. Wound in thigh is practically healed.

Diagnosis: Infected myoma of uterus, suppurative metritis. Metastatic abscess of thigh, septicæmia? Result: Cured. Patient discharged to go to the country.

Patient seen in December, is in perfect health. Has gained in weight even to excess. Color is that of a robust healthy woman.

Case XII.—*Secondary anæmia, following hemorrhage from cirsoid aneurism of face.*

I. G., New York Hospital. Surgical History No. 39,607. American girl, age 22. Admitted February 18, 1910. Service of Dr. Hartley.

Patient was born with a large vascular nævus over the left side of face, involving also the left ear which has always been larger than the right. The nævus grew and greatly disfigured the face and ear. Five years ago both carotid arteries were

ligated. Since then the mass has steadily increased in size, though more rapidly during the past two years. Eighteen months ago the ear became ulcerated, and foul-smelling pus has been continually discharged. Several severe hemorrhages have been checked with the greatest difficulty.

She is now suffering from pain, loss of appetite, loss of weight, nervousness, and anæmia.

Physical Examination.—Rather large girl with marked anæmia. There is a large pulsating tumor involving the left side of the face, scalp, and ear, which is about five times the natural size and much distorted. Immediately under the skin the tortuous outlines of large vessels are plainly visible. The lower half of the growth is ulcerated and emits a foul odor. The auditory canal is obliterated, and the sense of hearing is absent on this side. A loud systolic murmur is heard over the entire surface of the growth.

After admission to the hospital several hemorrhages occurred which were checked only by tight bandaging. Anæmia became marked and weakness extreme. Hæmoglobin readings fluctuated between 19 and 40 per cent.

On February 21 transfusion was performed. The donor was a highly neurotic sister who so excited the patient during the operation that an almost fatal hemorrhage occurred. The radial artery was first anastomosed to the saphenous vein near the ankle. As the flow was not satisfactory, a second anastomosis was made with the cephalic vein.

The transfusion resulted in little benefit, the hæmoglobin at the end reading only a few points higher than at the beginning. The loss of blood during the transfusion as the result of hemorrhage from the ulcer was very free, therefore it is likely that the hæmoglobin readings were not a true index of the amount of blood which passed.

The patient was discharged from the hospital March 29 unimproved.

BLOOD TRANSFUSION IN HÆMOPHILIA.*

BY CHARLES GOODMAN. M.D.,

OF NEW YORK,

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THE following case is reported as an evidence of the importance of blood transfusion in the treatment of hæmophilia.

The patient in question, a male, is two and one-half years of age, and is the third of four children, two of whom are females. He was admitted to the Beth Israel Hospital on July 10, 1909, twenty-four hours after having fallen from a fire-escape to the landing below. The child had sustained a lacerated wound of the right cheek, which was surrounded by a hæmatoma involving the entire right side of the face and extending to the lower eyelid. The buccal mucous membrane was lacerated in several places, and the upper lip completely severed. The latter had been sutured before admission to the hospital. Blood was oozing from all the wounds of the mouth and cheek.

A further examination of the child revealed the fact that the surface of the body was almost completely covered anteriorly and posteriorly with ecchymotic spots, varying in size from a ten-cent piece to a half dollar.

The patient was a fairly well-developed child for its age, but was exceedingly pale and appeared to have lost considerable blood. Upon inquiry into the history, the mother volunteered the following information:

"The child almost from birth showed a tendency to develop black and blue spots on the body upon the slightest injury. These spots often appeared after mere contact with some hard object, and would last from six to eight weeks. Ritual circumcision, performed on the eighth day after birth, was followed by continuous bleeding for several days. This was finally checked after several physicians had been called in, but not until the child was so ex-

* Patient presented before the Surgical Section of the New York Academy of Medicine, at the stated meeting held Nov. 5, 1909.

sanguinated that its life was despaired of. One year ago the child cut its finger and the wound bled for two weeks. About eight months ago the child fell and cut its gums, and this wound continued to ooze for several months."

Neither a history of consanguineous tie in the family nor that of hemorrhagic diathesis could be elicited.

The temperature of the child upon admission was 98.4°, pulse 150, urine was negative. During the first two days, the following measures were used to check the bleeding: application of adrenalin chloride, nitrate of silver, ice, and pressure with pledgets of gauze. Calcium chloride was administered by mouth, also tr. ferri chloridi. These were followed by calcium lactate and saline solution per rectum, and saline hypodermoclysis. On the morning of the second day 20 c.c. of diphtheria antitoxin were administered in two doses hypodermatically.

During the first day in the hospital the child vomited several times, bringing up several ounces of blood. On the following day he had several blood-stained movements.

In spite of all the measures used, the oozing continued, and although the loss of blood at times seemed insignificant, the child appeared to be getting weaker and weaker, as the pallor of the skin and mucous membrane became progressively more marked.

The transfusion of healthy blood was considered, and a donor sought for. The mother volunteered, but being at that time in her eighth month of pregnancy, and in view of the possibility of her having been responsible for the peculiar dyscrasia in the patient, was rejected. The father likewise was not considered, as he was poorly nourished, delicate, and anæmic, and could not have stood the loss of blood. A donor was readily obtained in a healthy applicant, nineteen years of age.

While Dr. J. J. Hertz, of the bacteriological department of the hospital, made the preliminary hæmolytic and the Wasserman and Noguchi tests, 5 c.c. of fresh serum obtained from a live rabbit was injected.

For a few hours the oozing from the wounds seemed to stop, but on the following morning, July 13, the little patient was in a distressing condition. He was apathetic and semicomatose, and his respirations labored and gasping. The temperature was 102°, and the pulse, which during the night had reached 180, had now become imperceptible. The tongue protruded, and the

patient was so weak and exhausted that he could not swallow any nourishment. The skin was decidedly waxy in appearance, the mucous membranes were slightly cyanotic.

The blood at this time, showed hæmoglobin 12 per cent., and less than 1,000,000 erythrocytes. The donor was quickly summoned and brought to the operating room with the child, and each was placed on the operating table ready for transfusion. The child was given one-eighth grain and the donor one-quarter grain of morphine hypodermically. For the exposure and dissection of the left radial artery of the donor I used a solution of ¼ per cent. cocaine; to an ounce of this solution ten minims of adrenalin 1 : 1000 had been added. After having dissected what I thought was the radial artery, I was perplexed on account of its small size and entire absence of pulsation in this vessel, and for a time I thought that I had to deal with an anomalous condition of the blood-vessels. The radial vein seemed a mere thread in size. I severed the artery and applied hot saline pads. At first three or four drops of blood appeared, and then there followed a good spurt of bright red blood. The Elsberg cannula was then applied. The distal end of the artery was cuffed over the cannula with the aid of the little tenacula designed for that purpose, and covered with saline pads. The femoral vein of the child was now rapidly exposed and lifted by two ligatures, the distal one being tied. This dissection was carried out without any anæsthesia, and there was no apparent objection on the part of the child, which lay almost lifeless on the table. I succeeded in introducing the cannula into a lateral opening of the femoral vein and opened the cannula.

After ten minutes there was a very slight change in the color of the lips, but there was only an occasional flutter of the child's pulse. The operating tables were of unequal height and could not be properly adjusted to favor an uninterrupted anastomosis, so I abandoned the femoral vein, and decided to try the upper extremity of the child. The basilic vein of the right arm was rapidly exposed, and although the vessel was of small calibre I succeeded with the aid of the little tenacula in introducing the cannula, holding the cuffed artery into this lumen. In the course of ten minutes the child showed the effects of the transfused blood by a gradual return of pulse and color. The transfusion was continued for twenty-eight minutes. At the end of that time, the

pulse was regular, of good quality, and 140 in frequency. The ears, cheeks, and lips, previously waxy, had now become pink. The hæmoglobin taken and measured with the Talquist scale recorded 70 per cent. and the child, previously having the appearance of a limp, lifeless body, was now transformed into a healthy living being. He became restless, and begged for nourishment.

It was indeed a dramatic moment as we watched the new blood gradually and surely enter the vessels of the subject, and give it a new lease of life. The donor was not greatly inconvenienced by the ordeal, and although obliged to remain in an absolutely quiet position for a prolonged time in the operating room, behaved like a stoic and stood the ordeal unflinchingly.

About an hour and a half after transfusion there was a sudden rise in the temperature to 106.4°, and a pulse of 190. This gradually subsided without treatment, and 12 hours later was 99, and the pulse 140. The child partook of nourishment, and with the exception of a slight temperature, due to some infection of the wound in the thigh due to derangement of the dressing, made an uninterrupted recovery.

The principal points of interest noted were that the oozing from the wounds was not only interrupted by the transfusion but absolutely checked by it. The ecchymotic spots which had covered almost the entire body of the child gradually faded away. With the exception of one spot on the forehead which appeared as a result of a fall, no new ecchymotic spots were observed. The spot disappeared in the course of a few days instead of remaining visible for weeks as formerly. He has not vomited nor passed any blood since the transfusion.

The patient when discharged from the hospital on the twenty-eighth day of July showed a red blood count of 3,400,000, and a hæmoglobin of 60 per cent. After spending three weeks at the sea-shore, the child was brought back to the city, and an examination of his blood showed 5,000,000 erythrocytes, and 80 per cent. hæmoglobin. He has since then passed through a normal course of measles without complications. More recently, following an infected scalp wound, cellulitis developed, which required extensive incisions for

proper drainage. The wounds healed gradually without showing any tendency to hemorrhage.

In conclusion the following point of interest should be mentioned: The mother gave birth to her fourth child in August, 1909. Notwithstanding the trying experience with the first male offspring, the parents had the infant circumcised on the eighth day. The infant was brought to the hospital ten days later to be treated for continuous bleeding from the wound. The two female children of this family show no tendency to bleed.

GRAFT OF THE VENA CAVA ON THE ABDOMINAL AORTA.

BY ALEXIS CARREL, M.D.,

OF NEW YORK.

(From the Laboratories of the Rockefeller Institute for Medical Research.)

I. INTRODUCTION.—The operation consisted of transplanting between the cut ends of the abdominal aorta a segment of vena cava. Its purpose was to study the details of the technic of the graft of a large vein on the aortic trunk and its remote results. It is important to know whether venous segments can replace parts of the aorta as successfully as parts of smaller arteries, the carotid for instance. Five years ago, I advocated the use of venous grafting in the treatment of aneurisms and of certain traumatic lesions of arteries.[1] It was warranted by the results of experiments that I had performed in 1902 in Lyons with Morel[2] and in 1905 in Chicago with Guthrie.[3] These experiments had shown that arteriovenous anastomoses made with a proper technic remain normal, and that a vein, transplanted on an artery, reacts against the increase of blood-pressure by thickening its wall. They demonstrated that veins can be safely grafted on arteries. At this time, it was believed that the successful arterial transplantation of a vein was not possible. Exner[4] had attempted several times to graft a segment of jugular vein on the carotid artery. The vein always became occluded. The results of Hoepfner[5] and of Goyanes[6] had also been negative. Payr[7] concluded that thrombosis was due to the action of the arterial blood-pressure on the thin venous wall, and that this biological factor rendered impossible the success of a venous transplantation. A short time afterwards, I was able to repeat these experiments at the University of Chicago. I found immediately that the thrombosis observed by previous experimenters was not due to a

biological but merely to a surgical cause, and that, with a proper technic, positive results could easily be obtained. Our experiments of 1905 and 1906 showed that arteriovenous anastomosis remained normal after twenty months. They also permitted the study of anatomical modifications of the venous wall under the influence of the increased blood-pressure. Eight months after the graft of a segment of jugular on the carotid, the circulation was found to be normal through the vein, the wall of which had become as resistant as an arterial wall.[8] It was, therefore, certain that veins followed the law of adaptation of organ to function, and that they could, when they were compelled to do so, play the rôle of arteries. In other experiments, made in 1907 and 1908 at the Rockefeller Institute, I was able to follow more closely the histological evolution of segments of jugular vein transplanted on the carotid, and observe that twenty months after the operation the venous segment was still in excellent condition.

These results have been confirmed by other experimenters in America and Europe. In 1907, in the laboratory of Harvey Cushing at Johns Hopkins University, Watts [9] performed several times the graft of a segment of jugular vein on the carotid artery. He found that the vein adapted itself to arterial function. Stich,[10] during the experiments made in 1907 and 1908 in the Klinik of Garré, was able to follow the evolution of a venous segment grafted on a carotid artery for 409 days. Fischer and Schmieden [11] also obtained positive results. In 1909, at the Pasteur Institute, Frouin [12] performed some arteriovenous anastomoses which became occluded after a few months. He did not realize that the occlusion was due to his defective technic, and concluded that it was the normal evolution of the anastomoses.

The information given by these experiments has been used only twice in human surgery. Goyanes performed, in 1906, an incomplete transplantation of the popliteal vein on the popliteal artery after extirpation of an aneurism, and his patient recovered. In 1907 in a case of axillary aneurism, Lexer [13] performed a graft of a segment of saphenous vein,

but his patient, whose general condition was very bad, died after a short time. On human beings, the technic of the arteriovenous anastomoses is easier than on dogs. They should be as successful, if they are performed with a proper technic and when the anatomical conditions of the artery allow it.

From an experimental stand-point the transplantation of venous segments can yield excellent results, even after a long time, when the operation is performed on dogs' carotid arteries. It is important to know whether these results will be different in case of larger and more friable vessels in which the blood-pressure is higher.

II. TECHNIC AND EXPERIMENTS.—The animals were etherized and their abdomens opened by a transverse semicircular laparotomy. The graft of the vena cava to the aorta was composed of four stages.

1. *Extirpation of a Segment of Vena Cava.*—At a short distance below the mouth of the renal veins, the vena cava was dissected and isolated between two ligatures. A venous segment very much longer than the arterial segment to be replaced was resected. It was then washed in Locke's solution, and deposited in a jar of vaseline.

2. *Temporary Hæmostasis, Section, and Resection of the Aorta.*—The abdominal aorta was dissected at the level of the genital arteries. The lumbar collateral branches were forcipressed or ligated. Between two Crile forceps, a long segment of aorta was isolated and a small part of it resected. As soon as the aorta was cut, the blood was washed out by an injection of Locke's solution. The vessel and the operative region were covered with vaseline, and isolated from the surrounding structures by black Japanese silk towels.

3. *Graft of the Vena Cava.*—The venous segment was removed from its jar, and interposed between the cut ends of the aorta, after the vaseline had been expressed from its lumen. The anastomoses were made by the ordinary method. Straight Kirby needles, No. 16, and fine silk threads, sterilized in vaseline, were used. The ends of the vessels were united by

three retaining stitches and a continuous through-and-through suture. As the diameter of the vena cava was larger than the diameter of the aorta, the calibre of the vena cava was progressively reduced. This could be done easily by leaving a larger distance between the stitches on the vein than on the artery. In order to secure an accurate approximation of the internal surfaces and a narrow scar, the edge of the vein was slightly eversed, the stitches were as loose as possible, and great care was taken not to include any connective tissue in the line of suture.

4. *Re-establishment of the Circulation.*—The Crile forceps placed on the lower end of the aorta was removed, and the blood entered the grafted segment. The sutures and the ligatures of the collateral branches of the vena cava were examined. The anastomoses were slightly compressed with dry gauze pads. The upper forceps were removed and the circulation re-established. After an arteriovenous anastomosis, the lines of sutures leak more or less for a few minutes, after which the hemorrhage stops spontaneously. If after two or three minutes there is still some hemorrhage, one or two stitches are added. The operation must not be ended before it is certain that not a drop of blood is oozing from the lines of suture. When the condition of the circulation was normal, the operation was completed by suture of the lumbar peritoneum and the closing of the abdominal section by four or five planes of suture. The animals were dressed and after a few hours allowed to walk and eat as usual.

Three experiments were performed on two cats and one dog.

Experiment 1: Transplantation of a segment of vena cava between the cut ends of the abdominal aorta.

Large yellow male cat. July 10, 1907. Dissection of the vena cava below the renal arteries. A segment three centimetres long is extirpated. Resection of the right kidney. Dissection and section of the aorta a few centimetres below the renal arteries. Graft between the ends of the segment of vena cava. July 15: Cat in normal condition. Normal pulsations of the femoral arteries. October 1: Cat in excellent health. No change in the femoral pulse. April 15, 1908: Femoral pulse normal. Cat slightly ill. April 25: Cat is sick. Femoral pulse normal. May 1,

1908: Pulse has disappeared. Animal walks normally. May 8: The animal is very sick. No femoral pulse. Killed by chloroform.

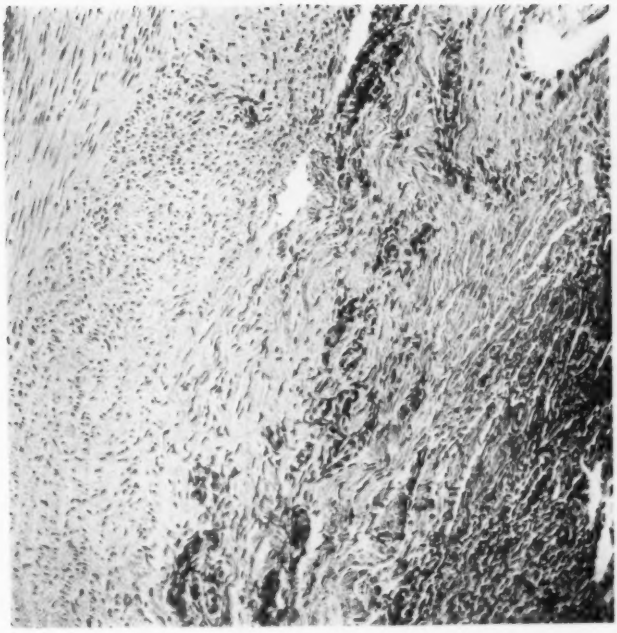
Autopsy.—Pyelonephritis, with perinephritic abscess. Obliteration of the transplanted segment by a clot of recent formation which is adherent to the wall. The aorta above and below the transplanted segment is normal. The calibre of the segment is almost the same as it was at the time of the operation. There is no sclerosis of the surrounding connective tissue. The venous wall is about the same thickness as the aortic wall. The internal surface of the lower part of the transplanted segment is smooth and glistening. On the upper part it is covered by a red clot, which is adherent to the wall at about one centimetre below the upper anastomosis. Both anastomoses are in perfect condition, smooth and glistening, and almost invisible. *Histological Examination.*—A small piece of the wall is cut at the level of the lower anastomosis. Section 97. Hæmatoxylin eosin and Weigert's elastic tissue stain. Longitudinal section of the vessel, showing the lower anastomosis and the adjoining parts of the aorta and vena cava. The wall of the vena cava is a little thicker than the wall of the aorta. The aortic wall is normal. Venous wall is composed of connective tissue with a few elongated cells. There are apparently no muscular cells. The union of the vena cava and of the aorta is very smooth. The aortic wall is slightly everted outward at the point of union. Very few elastic fibres in the venous wall, which is almost entirely composed of connective tissue.

Experiment 2: Resection of a small segment of the aorta of a cat. Graft of a segment of vena cava.

Large white male cat, very old. March 24, 1909, 10 A.M. Extirpation of a segment of vena cava of about 35 millimetres, just below the renal vein. Resection of a short segment of aorta at the level of the spermatic arteries. Graft of the vena cava between the cut ends. 3 P.M.: Animal walks about its cage. April 20: Femoral pulse normal. Animal is very fat and in good health. May 20: Animal is sick. Femoral pulse normal. May 25: Animal died.

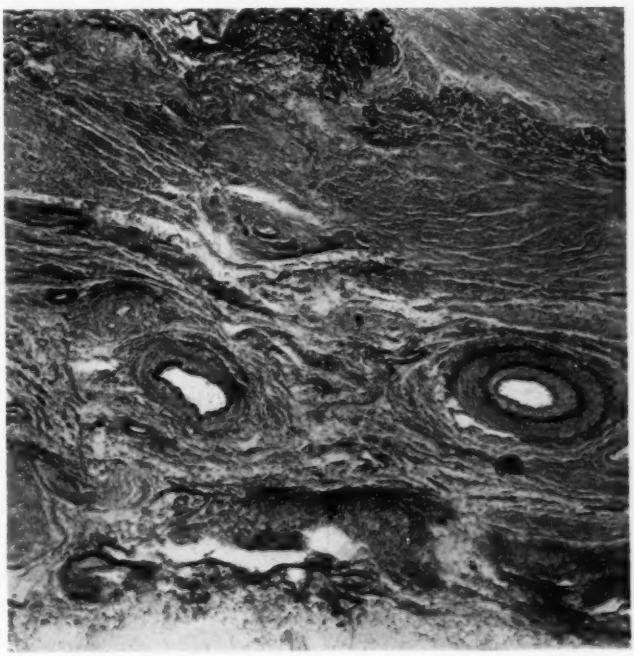
Autopsy.—Sclerosis of the kidneys. Fatty degeneration of the liver. *Macroscopical Examination.*—The transplanted segment is 34 millimetres long. Its calibre is larger than the calibre of the aorta. It does not seem more dilated than at the time of the operation. The walls of the aorta and vena cava are about of the same thickness. The internal surface is glistening, and slightly irregular. The anastomoses are excellent, without dilatation or stenosis. *Microscopical Examination.*—Hæmatoxylin eosin and Weigert elastic tissue stain. On a cross section of the transplanted segment, at about its middle part, the wall is composed of two parts—external and internal. The external coat is a very thick and well-vascularized adventitia; the internal part is composed of the media and of the intima. The media consists chiefly of very dense connective tissue and of elongated cell nuclei. Longitudinal section of the upper anastomoses shows the media of the aorta slightly bent outward and in perfect union with the vein (Fig. 1). There are no elastic fibres in the venous wall (Fig. 2).

FIG. 1.



Longitudinal section of the upper arteriovenous anastomosis. Experiment 2.

FIG. 2.



Same section stained by Weigert method.

FIG. 3.

Segment of vena cava transplanted on the abdominal aorta. Experiment 3. Fourteen months after the operation.

FIG. 4.

Venous wall, fourteen months after the transplantation. Experiment 3.

Experiment 3: Resection of a segment of the abdominal aorta patched with peritoneum. Graft of a segment of vena cava.

Middle-sized white bitch. November 24, 1908. Dissection of the abdominal aorta, a piece of which had been resected twenty-two months ago and replaced by a patch of peritoneum. Section of a segment of vena cava below the renal arteries. Resection of the patched segment of the aorta. Graft of the vein between the cut ends of the aorta.

November 25, 1908: Animal in good condition. Her hind legs are swollen. December 5, 1908: Œdema has disappeared almost completely. Animal in excellent condition. July, 1909: Animal normal. Normal femoral pulse. January 13, 1910: Animal died at the farm after an illness of a few days.

Autopsy.—Double pneumonia. Dissection of the aorta and of the venous segment which is 36 millimetres long. Its calibre has not markedly increased. The wall is very much thicker and a little transparent. The internal surface of both vessels is perfectly smooth and glistening, and anastomoses are excellent (Fig. 3). *Microscopical Examination.*—Intima a little thickened. The interstitial connective tissue has very much increased. The muscle-fibres are normal and seem to be increased in number. Very marked thickening of the adventitia (Fig. 4).

III. Results.—The three animals which underwent the transplantation of the vena cava on the abdominal aorta were in normal condition a few hours after the operation and recovered without any complication. In Experiment 3, the posterior limbs of the dog became swollen on account of the ligature of the vena cava but, after a short time, the œdema disappeared completely. No modification of the femoral pulse was observed. The causes, which after several months brought about, directly or indirectly, the death of the animals are completely independent of the operations. In Experiment 1, the cat was chloroformed ten months after the operation because he had developed pyelonephritis. The cat of Experiment 2 was very old. Three months after the operation, he became sick and died. The autopsy showed fatty degeneration of the liver and sclerosis of both kidneys. The dog of Experiment 3 lived in perfect health for fourteen months and then died of pneumonia in a few days.

Therefore, three months, ten months, and fourteen months after the operation the abdominal aorta of the animals and its venous segment were extirpated for the study of the anastomosis and of the venous wall.

Before longitudinal opening of the vessel the anastomoses

could not be precisely located. There was no hardening of the wall at their level. The surrounding connective tissue was not sclerosed. In Experiment 1, the segment was occluded by a clot of recent formation. But, both anastomoses were normal. Their lumen was free. The scar was indistinct. The exact location of the anastomosis was determined by the difference in color between the venous and the aortic walls. In Experiment 2, there was a linear scar. In Experiment 3, the scar was also very narrow and almost invisible (Fig. 3). But the location of the anastomoses was easily detected because the aortic wall assumed a white color while the venous wall was slightly bluish. The union between the ends of the aorta and the segment of vena cava was very intimate. The media of the aorta bent slightly outward and ended abruptly. On its internal surface, the intima increased progressively in thickness, the artery united itself to the vein without interposition of scar tissue. The histological appearance of the anastomoses after the operation shows that the results are definitive (Figs. 1 and 2). The secondary occlusions observed by Frouin are certainly the result of a fault of technic. When an arterio-venous anastomosis is made by a proper method, no modification of its lumen can occur even after a long time.

The venous segment underwent a slight increase of its calibre and a very marked thickening of its wall (Fig. 3). In every experiment its diameter appeared to be slightly enlarged. The changes of the wall were very marked. In Experiment 1, the venous segment was occluded by a clot of recent formation, which developed after the occurrence of pyelonephritis. Above and below the thrombus, the venous wall was smooth and glistening. In Experiments 2 and 3, the internal surface of the wall was perfectly smooth. There was a slight difference in color between the aortic and venous walls. The wall of the vena cava was a little thicker than the arterial wall. It had lost all elasticity, and did not contract when the circulation was stopped. It was composed in Experiments 1 and 2 of dense connective tissue, the adventitia and the media being very much increased. Development of new elastic fibres was not observed (Fig. 2). In Experiment 1, the muscle-

fibre nuclei disappeared. In Experiment 3, the muscle-fibres were found normal (Fig. 4). The thickening of the wall was due chiefly to a very marked sclerosis of the adventitia and of the media. It seemed that the number of the muscle-fibres had increased.

The adaptive changes of the vein begin immediately after its grafting on the artery. The wall thickens. There is, at first, an increase in the connective tissue, and probably also an increase in the number of the muscular fibres. Stich has observed the development of new elastic fibres. I observed it also in a few cases. But often, as it is shown in Experiments 1 and 2, there is no production of new elastic fibres. The elastic framework of the aorta stops abruptly at the point of anastomosis, and the venous wall is seen completely lacking in elastic tissue (Fig. 2). It seems that the first changes undergone by the vein can be compared to hypermyotrophy observed by Russell [14] in the first stage of certain forms of arteriosclerosis. It is a functional hypertrophy due to the increase of blood-pressure. It is not due to a change of nutrition produced by the arterial blood, because I found changes of the same nature in arteries in which the pressure was slightly raised, without any modification of the blood.

It is then certain that the first result of the increase of blood-pressure is an hypertrophy of the wall as it was shown long ago by Adami.[15] The vein has a tendency to become an artery. My experiments demonstrate that it can play perfectly its rôle. But it is possible that in some cases the wall undergoes a progressive sclerosis and that the muscle-fibres disappear completely after a few months. Four months after the transplantation of a segment of jugular on the carotid artery, I extirpated a small part of the wall and sutured the opening. The wall was very thick and composed of a sclerosed media containing normal muscle-fibres and of a greatly hypertrophied adventitia. Twenty months after the operation, the wall was examined again and modified. Sclerosis had increased and all the muscle had disappeared. This change did not interfere at all with the functions of the vena segment. Many experiments have shown that the presence of muscular

or elastic fibres is not necessary to the normal function of an artery. However, sclerosis of the wall may lead to atheromatous changes, although it has not yet been observed. But it will be necessary to keep under observation animals with veins transplanted on arteries for eight or ten years in order to be sure that these degenerative changes do not occur. The knowledge of the remote results of these operations will decide whether fresh veins or arteries, fresh or preserved in cold storage, must be selected as grafts.

IV. CONCLUSIONS.—The transplantation of the vena cava on the aorta is not a dangerous operation. The three animals operated on recovered without incident.

The venous wall reacts against the arterial blood-pressure by thickening its wall.

The condition of the venous wall and of the anastomoses examined fourteen months after the operation shows that, for a long time, a segment of vena cava can functionate as a part of the abdominal aorta.

It is probable that in the treatment of aneurism, rupture of large arteries, embolus, and localized arteritis, the transplantation of venous segments can be used safely, but it must be emphasized that without a proper technic, the results of the operation will be disastrous.

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A SUGGESTION FOR THE TREATMENT OF AIR EMBOLISM.

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THE object of this paper is to present the results of a study of air embolism with especial reference to its treatment. In this study other observations were of necessity made, but as these are mainly corroborative of work that has already been published—especially the work of Senn and Hare—a very brief account of it will be given.

Senn, in 1885,[1] reported an extensive experimental and clinical study of air embolism. Wherever our work has been in common with his, we are entirely in agreement. Our motive in attacking the problem was different from his and our methods are different. Hare[2] reported an extensive research done on dogs, which is entirely in agreement with the results of Senn and was done without any knowledge of Senn's work. Goodridge[3] criticizes previous work but adds nothing new. Ezra Read Larned[4] gives results corresponding to those of Senn and Hare. In these four papers, especially those by Senn and Hare, a complete literature of air embolism is given.

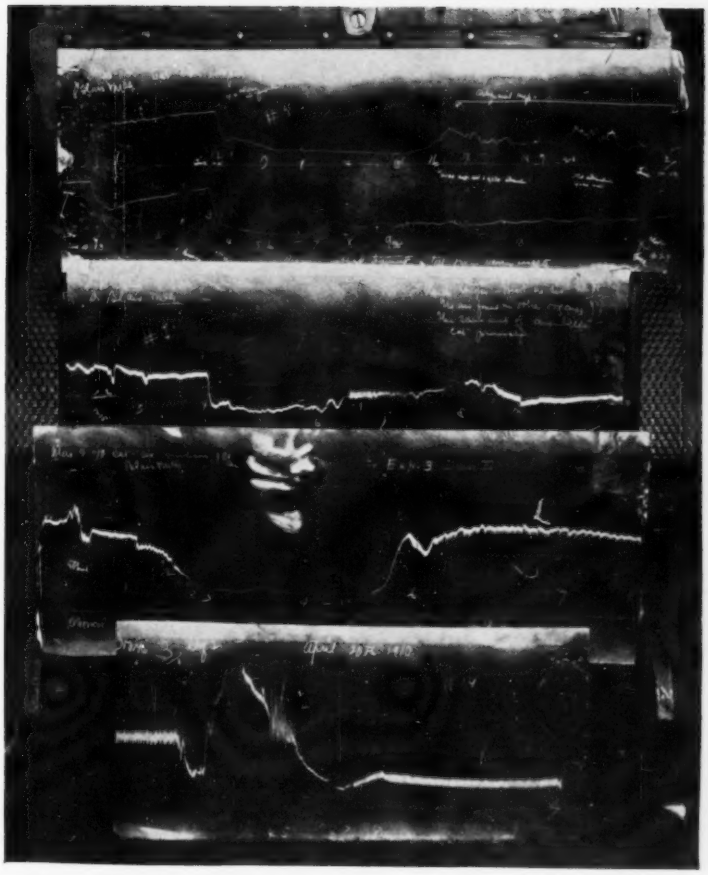
When air in quantity suddenly enters the veins, it may be rapidly fatal (see Experiments 5 and 7, Figs. 2 and 3). The fatal dose varies enormously with the same and different species. (Compare Experiment 14, Drum 2, Fig. 6, points 2, 3 and 4 in which the dog received 90 c.c. of air in the jugular under pressure in four minutes, from which he recovered with-

out treatment, also Experiment 21, Fig. 11, in which a dog aspirated about 175 c.c. air into the jugular in twenty-eight minutes with practically no serious effect, with Experiment 20, Fig. 10, in which a dog aspirated less than 15 c.c. of air in eleven minutes, which was almost immediately fatal.) As pointed out by Senn, Hare, Larned and others, in almost all animals the fatal dose is very much larger than is generally believed. The causes of death we have found are: (1) cardiac insufficiency due to a mechanical and to a vital cause; (2) respiratory failure.

When the air enters the right ventricle the auriculoventricular valve of that side does not close, and the light elastic air in the venæ cavæ allows regurgitation from the auricle. In the form of a coarse froth the air is churned backwards and forwards in the venæ cavæ with each contraction. This backward and forward motion of the air in large bubbles could be seen in the glass cannula in the jugular vein (see under method). The heart's effort is also apparently lessened. (See Experiment 11, B, Fig. 5, which shows a tracing of the excursion of the ventricular wall.) It will be seen that after each injection of 4 c.c. of air the contraction of the heart is considerably disturbed and is for a time less efficient. This may be due to lack of the stimulus of blood in the cavities. As a result of these two factors combined, little or no blood reaches the left ventricle, and the whole circulation including the coronary is stagnated, with consequent bulbar anæmia, causing respiratory failure, and cardiac anæmia, causing a real weakness and deterioration of the heart muscle. The possible influence of inhibitory impulses reaching the heart through the vagus is a subject that is reserved for further investigation.

It has been disputed whether cardiac or respiratory failure is the primary cause. In every case we found that the respiration stopped first, and if artificial respiration was carried out effectively, the heart in some cases would again resume normal function. While the respiration first fails and the heart continues to beat, yet the respiratory failure is dependent on the heart. Though the heart continues to beat, it throws out very

FIG. 1



Experiment 4: Dog revived of itself. Experiment 1: Cat revived with .9 saline. Experiment 3: Cat which failed to revive with .9 saline was revived with .9 saline and adrenalin. Experiment 14, Drum 3: Dog revived with adrenalin in a concentrated solution.

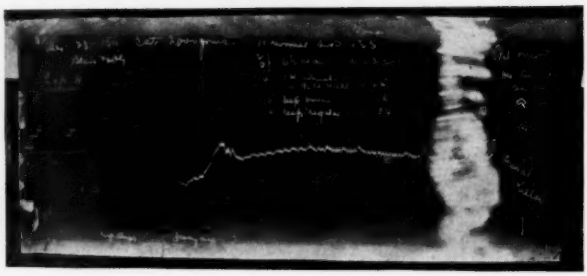
FIG. 2.

Experiment 5.

FIG. 3.

Experiment 7.

FIG. 4.

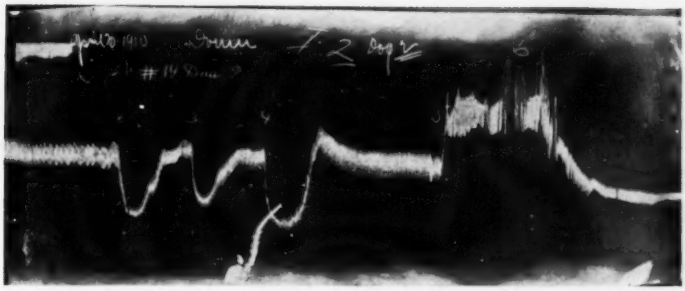


Experiment 8.

FIG. 5.

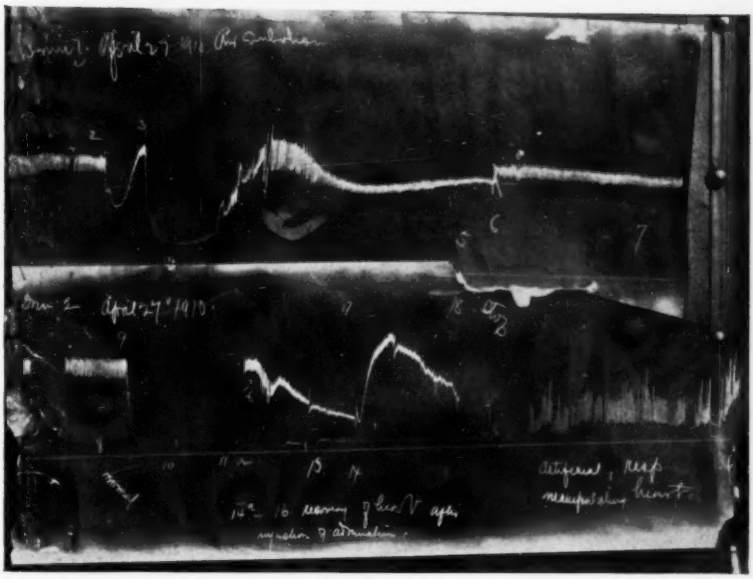
Experiment 11B.

FIG. 6.



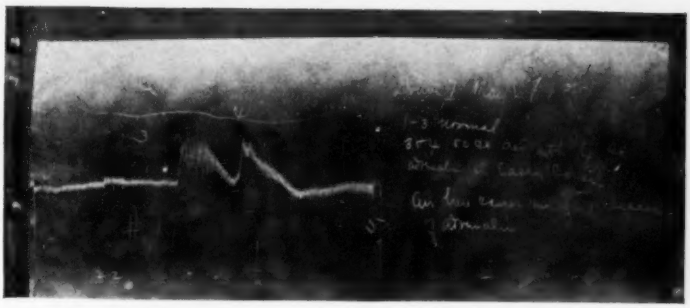
Experiment 14, Drum 2.

FIG. 7.



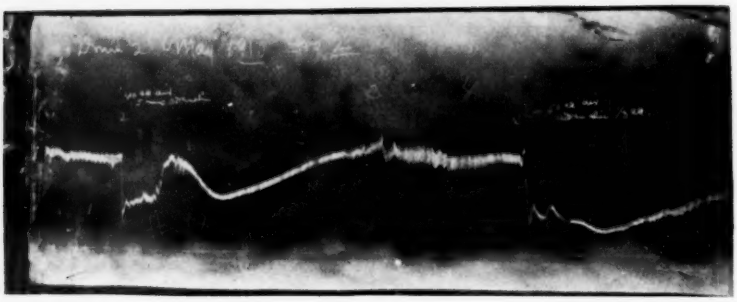
Experiment 15.

FIG. 8.



Experiment 17.

FIG. 9.

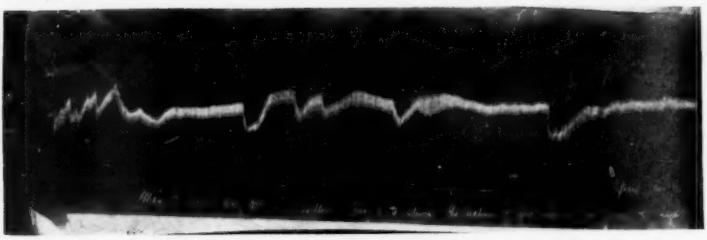


Experiment 18.

FIG. 10.

Experiment 20.

FIG. 11.



Experiment 21.

little blood, and because of this respiration stops from lack of nutrition of the respiratory centre.

The treatment that has so far been proposed has been both direct and indirect. It may be stated under the following headings: (1) the prevention of the admission of air by compression or ligation or both; (2) venesection; (3) cardiac stimulants; (4) direct aspiration of the heart and infusion of saline solution; (5) catheterization and aspiration of the right auricle to remove air and spumous blood and to relieve overdistention.

No doubt the proper use of any of these methods is of value. Some, however, are extremely heroic and others, apparently without danger, we have found to be decidedly detrimental. Many cases of air embolism, if left alone and untreated, will recover (see Experiment 4, Fig. 1). It must be an accident of very rare clinical occurrence but if it does occur, treatment to be effective must, in most cases, be quickly applied. The call for a comparatively conservative method, one that will be beneficial in all cases and detrimental in none, is quite obvious. It was the desire for such a method that prompted the present research.

Our first experiment in the line of treatment was to open the chest wall and attempt to re-establish the circulation by cardiac massage. This was proved futile both by the death of the animal and the failure to remove the air from the heart.

The next therapeutic attempt more nearly approached a clinical possibility, and was based on the theory that if the right heart could be but partially filled with fluid under pressure it would help to sweep the air into the pulmonary circulation, and the impact of the fluid against the valve cusps would cause them to close in the normal manner. We had observed that once the circulation was re-established, the vicious circle was broken, and that large quantities of air would be disposed of without causing serious embarrassment.

As an adjunct to flushing the right heart, it seemed to us that if an artery on the systemic circulation were opened, it would have the double effect of lessening the starting load and

of partially compensating for the quantity of salt solution that we proposed to throw into the right heart. Though we did succeed in at least hastening the recovery of one animal (Experiment 1, Fig. 1) by this method, it did not work out as we had hoped. In most cases it failed and it proved more apt to cause paralysis of the heart than restoration of function. While we were carrying on this work, L. von Lesser [5] reported the simple infusion of saline as valuable; Von Lesser used 0.5 per cent. NaCl solution. We found no sufficient merit in the method. Not only does the method of simple saline infusion seem to have little to recommend it in any case, but it is decidedly dangerous. The heart is already weak and tends to dilate. When salt solution is injected quickly and in volumes sufficient to help sweep the air out of the heart, it almost invariably causes a dilatation that is harmful, often fatal. In several experiments, in running the saline into the vein at 90 cm. of water pressure, the heart suddenly ceased beating and on opening the chest no beat could be observed, but on simply opening the pericardium an ineffective beat was resumed. If the saline solution be injected slowly, it is of no value, although Goodridge advises injection into the median basilic vein in conjunction with direct aspiration of the heart with a fine trocar.

From what we observed while working on this method, it seemed that the fault lay in the fact that the heart would not respond to the extra load, and that if some powerful instantaneous cardiac stimulant could be brought to bear this fault might be overcome. The addition of adrenalin chloride to the salt solution proved decidedly advantageous, greatly increasing the percentage of recoveries. This is demonstrated by Experiment 3, Fig. 1, where salt solution and artificial respiration failed, but prompt recovery occurred on flushing with 50 c.c. of 0.9 saline containing 1 c.c. of a 1 : 1000 adrenalin chloride solution, and Experiment 8, Fig. 4, where recovery followed the use of 1 c.c. adrenalin chloride solution in 90 c.c. of 0.9 saline solution. Adrenalin in this dilution did not, however, entirely eliminate the danger of cardiac paralysis where large

quantities of fluid were rushed to the heart (see Experiment 7, Figs. 3, 9 and 13).

EXPERIMENT 1, MARCH 10, 1910.

Cat, Weight 3000 Grammes.

Time	Blood-pressure Hg.
12.15: Normal blood-pressure	92 mm.
12.15: 1 c.c. air, blood-pressure immediately	74 mm.
12.18: Blood-pressure	84 mm.
12.20: 3 c.c. air in jugular	52 mm.
12.22:	28 mm.
12.22: 100 c.c. normal salt sol. in jugular	
12.27: Blood-pressure	60 mm.
12.38: Blood-pressure	88 mm.
1.00: Cat, normal, killed.	
Autopsy: no air could be found in any of the organs.	

EXPERIMENT 2, MARCH, 1910.

A number of experiments were made that are not recorded here. In most instances the injection of air, saline, or adrenalin, and the resulting blood-pressure are recorded as being synchronous, but in reality the blood-pressure reading was made a fraction of a minute later than the injection.

Cat, Weight 4100 Grammes.

Time	Blood-pressure Hg.
11.45: Normal blood-pressure	180 mm.
11.46: 3 c.c. air in jugular	140 mm.
11.46½:	184 mm.
11.47: 4 c.c. air	108 mm.
11.49:	170 mm.
11.50: 4 c.c. air	98 mm.
11.51: 4 c.c. air	70 mm.
11.52:	110 mm.
11.52½: 4 c.c. air	50 mm.
11.54:	28 mm.
Commenced to run in salt solution at a pressure of 90 cm. water—no recovery.	

EXPERIMENT 3, MARCH 9, 1910.

Cat, Weight 2500 Grammes.

Time	Blood-pressure Hg.
12.07 : Blood-pressure	120 mm.
12.08.5: 4 c.c. air in jugular	42 mm.
12.09.5: Commenced to run in salt solution in jugular—100 c.c. run in.	
12.11 : Artificial respiration.	

Time		Blood-pressure Hg.
11.49	:	170 mm.
12.12	: No heart-beat felt—respiration very slow, blood-pressure.	30 mm.
12.12	: Adrenalin 1 c.c. in 100 c.c. saline ran into jugular.	
12.14	: Blood-pressure	130 mm.
12.15	: 47 c.c. blood drawn from femoral.	
12.17	: Respiration jerky but becoming normal.	
12.43	: Animal in good condition, blood-pressure	120 mm.

In this case after salt solution had failed, the animal was in very poor condition; adrenalin caused a complete recovery.

Postmortem.—The heart was normal, no air could be found in any of the organs.

EXPERIMENT 4, MARCH 12, 1910.

Cat, Weight 1500 Grammes.

Time		Blood-pressure Hg.
10.00	: Normal blood-pressure	108 mm.
10.03	: 3 c.c. air in jugular, pressure falls to	68 mm.
10.07	: Blood-clots in cannula	92 mm.
10.08	: 4.5 c.c. air in jugular	20 mm.
10.09	: Respiration very slow and deep and at,	
10.09.5	: Respiration practically ceased, heart impulse can still be seen, blood-pressure	22 mm.
10.10.5	: Great dyspnœa, blood dark and clots readily, blood-pressure	28 mm.
10.12	: Respiration and heart improved	32 mm.
10.18	: Respirations 3 per minute	42 mm.
10.30	: Respiration regular, 14 per minute	84 mm.
	The animal here normal so far as can be judged.	
10.31	: 4.5 c.c. more air in jugular and pressure falls quickly to 22 mm.	
10.40	: No respirations in 2 minutes and heart-beat scarcely perceptible.	
10.41	: Artificial respirations commenced and 0.5 c.c. adrenalin in 60 c.c. salt solution injected into jugular. But treatment apparently without result. Heart-beat revived but continuous cardiac massage necessary, and heart stops on withdrawing the treatment.	

Postmortem.—11.00: Air was found in both sides of the heart and in the coronary veins. When the heart was removed from the body it still beat but not effectively. More prolonged treatment might have been effective.

Results.—This small animal recovered completely from a large volume of air without treatment. As a smaller volume has killed a larger animal, this fact makes it difficult to place a true estimate on treatment, as the animal, if left alone, recovers in many cases.

EXPERIMENT 5, MARCH 16, 1910.

Cat, Weight 3500 Grammes (Male).

Time		Blood-pressure Hg.
10.03:	Normal pressure	164 mm.
10.05:	4.5 c.c. air in jugular	80 mm.
10.07:		150 mm.
10.09:	4.5 c.c. air in jugular	30 mm.
11.12:	40 c.c. salt solution	20 mm.
	Containing 1 c.c. adrenalin, this was repeated in 1 minute —no sign of recovery.	
11.20:	Animal dead.	

Postmortem.—Clot in right heart. Air in right heart, lungs, and inferior vena cava back to liver, no air in left heart.

EXPERIMENT 6, MARCH 19, 1910.

Cat, Weight 1600 Grammes.

Time		Blood-pressure Hg.
10.40:	Normal pressure	128 mm.
10.41:	4.5 c.c. air in jugular	4 mm.
	Animal died immediately, adrenalin in salt solution; bleeding gave no signs of recovery.	

EXPERIMENT 7, MARCH 16, 1910.

Cat, Weight 2500 Grammes.

Blood-pressure 134 mm. Was injected with 9 c.c. air—pressure fell at once to zero and treatment with adrenalin and salt was ineffective.

Autopsy.—Showed air in all abdominal veins, air in right heart, no air in left heart, not dilated.

EXPERIMENT 8, MARCH 23, 1910.

Cat, Weight 2000 Grammes.

Time		Blood-pressure Hg.
10.20–23:	Normal blood-pressure	118 mm.
10.23:	6.5 c.c. air in jugular	10 mm.
10.25:	Respiration stopped, no heart-beat perceptible; 1 c.c. adrenalin in 90 c.c. salt solution and pressure immediately rises.	
10.26:	Respiration jerky and becoming more frequent.	
10.28:	Respiration labored but becoming more regular	120 mm.
10.30:	Animal normal in respiration and pressure	120 mm.
10.37:	Animal killed.	

Postmortem.—No air found in any organs, all normal. In this case the adrenalin may have been the direct cause of recovery.

EXPERIMENT 9, MARCH 25, 1910.

Cat, Weight 2350 Grammes.

Time	Blood-pressure Hg.
11.15 : Normal pressure	140 mm.
11.16 : 9 c.c. air in jugular.	
11.16.5: Respiration stopped, heart still beating	10 mm.
11.17.5: Respiration 1 per minute.	
11.18.5: Heart 180 per minute	8 mm.
Adrenalin salt solution and artificial respiration gave no sign of being beneficial.	
11.30 : *Autopsy*—air in right and left heart and vena cava. After the removal of the air the heart commenced to beat. In this case after the adrenalin had been used without effect, aspiration might have been beneficial.	

EXPERIMENT 10, MARCH 26, 1910.

Dog, Weight 6350 Grammes.

Time	Blood-pressure Hg.
11.14: Normal pressure	160 mm.
11.15: 9 c.c. air in jugular	140 mm.
11.15¾: Respiration labored, pressure	160 mm.
11.18.5–11.19.5: 35 c.c. air injected	68 mm.
11.20:	164 mm.
11.35: Animal normal, pressure	160 mm.
11.38.5: 50 c.c. air injected	50 mm.
11.40:	160 mm.
11.45: 170 c.c. air injected	20 mm.
11.46: Respiration stopped, heart weak, injection of salt solution 100 c.c. 0.9 and adrenalin in 1 c.c. caused a slight improvement.	
11.48: Dog gasping	40 mm.
100 c.c. more salt solution containing 1 c.c. adrenalin and artificial respiration gave no further improvement.	
11.50: Animal dead.	

Autopsy.—Air in all chambers of heart and abdominal vessels.

EXPERIMENT 11, APRIL 12, 1910.

100 c.c. air killed a 20 lb. dog and all treatment was useless. Death immediately, heart dilated and air in both sides.

11A. 50 c.c. killed a 17 lb. dog immediately; by the injection of 300 c.c. salt solution in jugular, bleeding from the carotid, we were able to wash some of the air out of the heart, but this treatment was ineffective. The heart continued to beat weakly after respiration ceased.

11B. Shows a myocardiogram of cat during repeated injections of 4 c.c. air.

Experiment 12 similar to 11.

EXPERIMENT 13, APRIL 20, 1910.

Dog, Weight 24 Pounds.

Time	Blood-pressure Hg.
11.35 : Normal blood-pressure	124 mm.
11.40 : 40 c.c. air in jugular	78 mm.
11.41 :	140 mm.
11.46 : 50 c.c. air	28 mm.
11.46.5 :	28 mm.
11.48 : Respiration stopped; 1 c.c. adrenalin in 100 c.c. salt solution ran in at 50 cm. water pressure gives no improvement.	
11.49.5 : Heart flickering, artificial respiration does no good.	

Autopsy.—A little air in abdominal veins. None in the small veins. Air in right ventricle and pulmonary arteries but none in left ventricle.

EXPERIMENT 14, APRIL 20, 1910.

Dog.

Time	Blood-pressure Hg.
12.36 : Normal pressure	140 mm.
12.39 : 35 c.c. air in jugular, respiration becomes very rapid and pressure falls to	62 mm.
12.40.5 : Pressure	144 mm.
12.41 : 25 c.c. air injected, hyperpnœa and pressure falls to	80 mm.
12.43 : Pressure	140 mm.
30 c.c. air injected, respiration resembles vomiting movements and pressure falls to	54 mm.
12.46 : Pressure	150 mm.
12.48 : 1 c.c. adrenalin in 4 c.c. saline injected—typical adrenalin action.	
12.52 : Pressure	100 mm.
12.53 : Stopped to clean out clot.	
1.01.5 : Normal pressure	130 mm.
1.02 : 40 c.c. air in jugular, pressure falls to	75 mm.
1.03.5 : Respiration stopped, pressure	76 mm.
1 c.c. adrenalin solution injected gives typical adrenalin rise.	
1.04 : 75 c.c. blood taken from femoral.	
1.07 :	58 mm.
1.08 : 230 c.c. salt solution injected at a pressure of 30 cm. water.	
1.15 : Steady for 5 minutes at	80 mm.
Experiment stopped and animal killed.	

Autopsy.—No air found in heart, lungs, or large veins, or coronary arteries. Organs apparently normal.

Results.—Adrenalin quickly restored animal after respiration had ceased, but while pressure was still high. Unquestionably the animal

would have recovered without treatment, but recovery was much quicker with it. Bleeding relieves the pressure and allows the adrenalin to act on the heart without the probability of danger from high blood-pressure. A remarkable feature was the complete absorption of 130 c.c. of air in 40 minutes or less.

EXPERIMENT 15, APRIL 27, 1910.

Dog, Weight 28 Pounds.

Time	Blood-pressure Hg.
11.05: Blood-pressure	124 mm.
11.05.5: 50 c.c. air in jugular.	
11.06: Pressure	70 mm.
11.07: Pressure	140 mm.
50 c.c. air injected.	
11.08: Respiration stopped, heart very weak, pressure	28 mm.
1 c.c. adrenalin in 80 c.c. salt solution at 45 cm. water pressure. Immediate good effect.	
11.09: Pressure rising rapidly and respiration improving.	
11.10: Blood-pressure	140 mm.
11.15: Blood clotting	110 mm.
11.25: Respiration normal, blood-pressure	138 mm.
The treatment here is unquestionably effective.	
11.30: Blood-pressure	120 mm.
11.30.5: 90 c.c. air injected.	
11.31: Respiration stopped, heart very weak, blood-pressure	16 mm.
Adrenalin, artificial respiration, vagi cut and salt solution—could not restore animal.	
11.50: Chest opened and direct massage of the heart restored beat.	
11.52: Heart revived and in good condition.	
11.58: Experiment stopped.	

Postmortem.—Air in the vena cava and right heart, none in left heart.

Results.—Adrenalin was decidedly beneficial in this case. This is especially the case when the heart is almost able to overcome the obstruction without help. When the blood-pressure falls to almost zero and quickly it is of less value. When a very large volume of air is injected adrenalin fails.

EXPERIMENT 16, APRIL 28, 1910.

Dog, Weight 25 Pounds.

Time	Blood-pressure Hg
11.17: Normal blood-pressure	164 mm.
11.18: 100 c.c. air in jugular, pressure immediately falls, and at	
11.20:	18 mm.

Adrenalin and salt solution was ineffective. The animal died without the faintest appearance of recovery. This amount of air forced into the heart makes it impossible to force in salt solution and adrenalin. In

fact, if the cannula is open, much of the air would pass out through the same veins that it entered. Such an amount of air could but slowly enter the heart at normal pressure.

EXPERIMENT 17.

Dog, Weight 16 Pounds.

This experiment was made to demonstrate the antagonistic effects of air and adrenalin on the heart.

Time	Blood-pressure Hg.
11.38: Normal blood-pressure	130 mm.
11.43: Normal blood-pressure	130 mm.
11.43: 50 c.c. air used to force in adrenalin. There was no fall in this case. A small adrenalin rise which soon reached normal again.	
11.46: Blood-pressure	132 mm.
The above injection was repeated with like results.	
11.48: Blood-pressure	130 mm.

The air in this case, 100 c.c. in a small dog, caused no fall of pressure.

Postmortem.—Air in the pulmonary artery. Fine bubbles of air in right heart but none in left; heart beat strong for some time after removal from body.

EXPERIMENT 18.

Dog, Weight 10 Pounds (Good Tracing).

To show the influence of adrenalin injected immediately after air.

Time	Blood-pressure Hg.
12.30: Normal pressure	128 mm.
12.35: 40 c.c. air followed immediately by 0.4 c.c. adrenalin. Pressure falls to	50 mm.
Immediately begins to rise.	
12.36:	70 mm.
12.39:	120 mm.
12.45:	130 mm.
12.45.5: 50 c.c. air followed immediately by 0.4 c.c. adrenalin. Heart is strong in pressure and slow and gradual.	
12.47:	70 mm.
12.50:	40 mm.
After this the rise was gradually higher.	
12.52:	90 mm.
1.00:	98 mm.
1.00: 85 c.c. air.	
1.01: Pressure falls to	10 mm.
And adrenalin, salt solution and artificial respiration failed to revive.	

Autopsy.—Air in right heart and coronary veins, and abdominal veins. No air in left ventricle.

EXPERIMENT 19, MAY 6, 1910.

Dog, Weight 8 Pounds.

30 c.c. air killed this animal immediately and adrenalin was without effect—administered 1 minute after the air.

EXPERIMENT 20.

A dog, weight 9 pounds, with trachea clamped during the period of the first three respiratory efforts, and cannula in jugular connected with condom containing a measured amount of air. During 29 respirations the animal drew into the vein between 10 c.c. and 15 c.c. air, which killed it.

Adrenalin was without effect. The measuring apparatus was not perfectly satisfactory and the experiment was repeated. The imperfection here was lack of exactitude in the measurement of the air. The air was aspirated from an unstretched thin rubber bag and the possible error was within the limits named.

EXPERIMENT 21.

Dog, weight 20 pounds; with a perfect apparatus the animal could not draw in enough air to kill it.

Our next method was to introduce into the heart a rather concentrated solution of adrenalin, using a relatively small quantity of normal saline solution to carry it from the jugular vein, where it was introduced. The essential difference between this and the preceding method is that reliance is placed chiefly upon a very concentrated solution of adrenalin reaching the heart chambers and causing violent contractions. The normal saline solution is used chiefly as a carrier and in quantity sufficiently small to insure its freedom from the danger of overdistention. The exact technic was to inject the quantity desired of the 1 : 1000 adrenalin chloride solution by means of a hypodermic into the rubber tube that leads to the cannula in the vein. By this means the adrenalin was concentrated in the first part of saline that entered the vein, the remaining saline being used to insure its reaching the heart. It is because of our apparently successful results with this drug that we report the work. Artificial respiration is often of value, whatever other treatment may be instituted.

METHODS.

Cats and dogs were used. The animals were prepared for blood-pressure tracings. A cannula was inserted in the

right external jugular close to its innominate junction, for the injection of air and adrenalin and salt solution. A continuous blood-pressure tracing was taken during the experiment, and is recorded in millimetres mercury. A measured volume of air was injected in each case. When the quantity was small, injection was made with an air-tight syringe; when over 10 c.c. it was pressed in by a syphon.

To simplify description, the general results obtained will be given, twenty-two of the series having been presented in tabular form.

Injection of air into the heart, no matter how small the quantity may be, produces a disturbance of the circulation that can readily be seen in the blood-pressure record; there are a fall of pressure, dyspnœic symptoms, and restlessness. If the volume of air injected be small, these changes are usually extremely temporary; if large, a sudden fall of pressure to almost the base line occurs, great dyspnœic and labored breathing, and a fluttering heart. The respiration always stops before the heart, but the ineffectiveness of the heart-beat is the cause of the respiratory failure. In other words the practically valveless right heart cannot supply blood to be pumped to the respiratory centre and the centre fails while the heart continues to beat ineffectively, the blood-pressure being almost zero. While the heart is in this condition, the injection of adrenalin is very effective in restoring the normal pressure in some cases; in others it is worthless; whether or not it is of value seemed to depend largely upon the character of the heart-beat at the time the injection was made and the length of time that had elapsed since respiration ceased. Except where air or fluid is rushed into the heart under considerable pressure, the heart-beat does not cease for some time, but the beat becomes less and less strong. Where at autopsy, after rushing air and fluid into the heart, no beat was seen, the beat always recurred on opening the heart and removing the internal pressure. In all cases where at postmortem air was found in quantity in the left heart, adrenalin was ineffective. The action of adrenalin can also be most clearly seen if it is injected with the air, or closely fol-

lowing (Experiments 17, Fig. 8, and 18, Fig. 9). In Experiment 17 the air was injected at low pressure and the adrenalin effect predominated. In 18 the air was injected suddenly at considerable pressure and then there is a fall of blood-pressure before the adrenalin "takes hold." As already shown, the result of air injection under apparently similar circumstances is so variable, that from a relatively small number of experiments, negative conclusions cannot be drawn, but this does not decrease the value of certain definite observations that were made, nor does it preclude using these positive observations as the bases of the certain positive conclusions. Besides the variable amounts of air that could be taken into the venous circulation close to the heart before lethal symptoms resulted, the most interesting observation was the rapidity with which large quantities of air were disposed of after the circulation was once established. Experiment 21, Fig. 11, was started at 11.20 and the heart was clamped at 12 A.M. During this time the dog had aspirated 175 c.c. air through the jugular vein. No air was found in the venæ cavæ; ⅓ c.c. air was obtained from the right ventricle and a minute bubble from the left. Under water in a bell-jar, no air could be washed from the pulmonary vessels, using water syphoned from a height of two metres. This rapid absorption or elimination of air was demonstrated in a number of experiments.

During these experiments we observed nothing that would verify the conclusions that the depression accompanying air embolism is due to blocking of the pulmonary vessels with air, but the rarity with which traces of air were found on the left side of the heart or were seen in the carotid cannula, even after large quantities of air, 100 c.c. or more, had been rapidly disposed of, leads us to the tentative conclusion that at least a part of the air was either eliminated or absorbed while passing through the pulmonary circulation. (See Experiment 14,—130 c.c. of air had entirely disappeared after 40 minutes.)

It was observed that with an open cannula in the proximal end of the jugular vein, air was aspirated into the vein with the first inspiration, but that almost immediately there was a back

pressure from the leaking heart. If the cannula was left in the vein and the open end inserted into an undistended, thin rubber bag containing a measured quantity of air, it was found that air was aspirated interruptedly (see Experiment 21, Fig. 11).

Based on the observations made during these experiments, we believe that death from air embolism is clinically a rare occurrence, but should grave depression follow the aspiration of air into a vein, the treatment we propose is the introduction of adrenalin chloride in a fairly concentrated solution, 1 : 10,000 to 1 : 1000, directly into the right ventricle and that this be accompanied by a small amount of normal saline solution. In our experiments we always used 40 c.c. or more of saline solution, but in most cases a large quantity of air had been put in under pressure and it required a pressure of 60 cm. of water to force the fluid into the vein.

For clinical application a fine hypodermic needle could be pushed through the chest wall directly into the right heart, which could be done by inserting the needle through the chest wall and lung at the anterior extremity of the third or fourth right intercostal spaces. We observed no evil effects in dogs from perforating the heart wall with a fine needle, but to attempt to do it through the chest wall would be a very uncertain procedure.

Air embolism usually results from operations in the neck, in which large veins are exposed. We believe a practical application of this treatment would be to insert a douche point or transfusion needle attached to some sort of transfusion apparatus or douche can containing normal saline. The adrenalin chloride can be introduced into the tube of the douche apparatus close to the vein by piercing it with a hypodermic needle. The water can be put in with probable safety at a pressure of 25 to 30 cm. of water pressure.

In regard to the quantity of a 1 : 1000 adrenalin solution to be used, we would suggest that 2 c.c. be tried in a severe depression and repeated. In dogs, ¼ c.c. was sometimes effective, and the extreme activity resulting from a large dose

was of but a short duration (Experiment 15, Fig. 7, and also 14, Drum 2, Fig. 6) and any dangerous symptoms short of apoplexy arising from an overdose can be modified by bleeding from an artery (Experiment 14, Drum 3, Fig. 1).

Artificial respiration according to the Schafer method should be employed when respiration ceases. As a last resort, the chest might be opened and direct cardiac massage applied (see Experiment 15, Fig. 7). We revived two dogs in this manner after giving the adrenalin. The experiments of Senn show that horses are more severely affected by air embolism in the erect than in the recumbent position, and we advise this position during the effort at resuscitation.

In animals in which the air was forced in under pressure, it was necessary in most cases to apply the remedy within two minutes, but it is probable in many clinical cases in which small quantities of air were aspirated that sufficient time will elapse between the accident and death to allow of some attempt to save them.

The violent contraction of the heart muscle that results from the introduction of a concentrated adrenalin chloride solution into its cavities, is the most efficient agent that we found for restoring a circulation embarrassed by air embolism (see Experiments 4, 1, 3, and 14, Drum 3, Fig. 1).

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PRESERVATION OF THE SUBMAXILLARY BRANCH OF THE FACIAL NERVE IN OPERATIONS ON THE NECK.

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In considering the permanent results of the operative and non-operative treatment of tubercular cervical lymph-nodes, we must not lose sight of the scars and deformities occasioned by the disease or by surgical interference. Not least among these is paralysis of that branch of the facial nerve which supplies the depressor muscles of the lip. This branch, from its emergence from the parotid gland to its entrance into the depressor muscles, lies in intimate contact with the nodes most frequently involved in the tuberculous process, and is very often pressed on, cut, torn or crushed with a resulting more or less complete and permanent paralysis of the lower lip. This deformity is not inconsiderable, and its avoidance is worth serious attention.

The descending or cervicofacial branch of the facial nerve divides between the lobes of the parotid gland into three main branches,—the transverse, which immediately pierces the mesenteric fascia and supplies the upper or facial portion of the platysma; the descending branch, which leads obliquely downward and forward to become superficial after piercing the deep fascia about the angle of the jaw and supplies the cervical portion of the platysma in conjunction with the superficial branches of the cervical plexus; and the submaxillary branch (collo-mandibularis of Jaffé), which remains beneath the superficial layer of the deep fascia during its entire course from the angle of the jaw and beneath the ramus, which it crosses with the facial vessels. The first two branches are of no practical importance, but this submaxillary portion supplies the depressor labii inferioris and the depressor anguli oris, and its injury

results in a paralysis which is very noticeable in smiling, crying, etc. If the nerve is injured beyond repair the paralysis is permanent, as is proven by numerous experiences.

The statement is sometimes made that other branches of the facial or the cervical nerve will compensate for this loss, but this is as unreasonable as to expect a restoration of function in paralysis of the levator palpebræ or following permanent Bell's paralysis, or the paralysis of any given muscle with single nerve supply. Motor nerves are end nerves, so to speak, and do not take up the function of neighboring structures. It is probable that the occasional recoveries from this paralysis are due to a minor degree of trauma primarily, or perhaps to a union of the severed nerve when the ends are favorably placed.

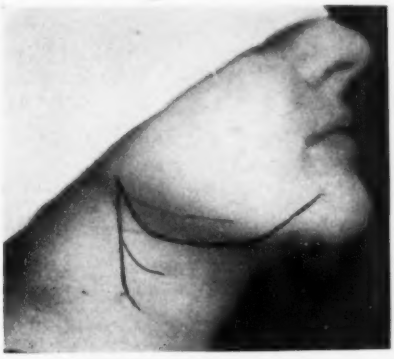
To avoid injuring the nerve, incisions in front of the sternomastoid should always be transverse and at least three-quarters of an inch below the jaw. The deep fascia should be incised freely until the vessels and submaxillary salivary gland are exposed. The nerve clings tightly to the under surface of the superficial layer of the deep fascia, and is usually one-fourth to one-half inch below the jaw. It will be retracted with the upper flap and is safe except in the removal of the nodes above the salivary gland. Here the dissection must be blunt, from within upward and outward, and even with the greatest care the nerve will sometimes be injured. If so, the severed ends should be reunited at once.

The illustrations show fairly well the relations of the nerve to the various structures in the neck, particularly the deep fascia. The author wishes to express his gratitude to Professor Haynes, under whose direction the dissections were made at the Cornell University Medical School, and to Doctor Charles N. Dowd for his advice and encouragement.

FIG. 1.

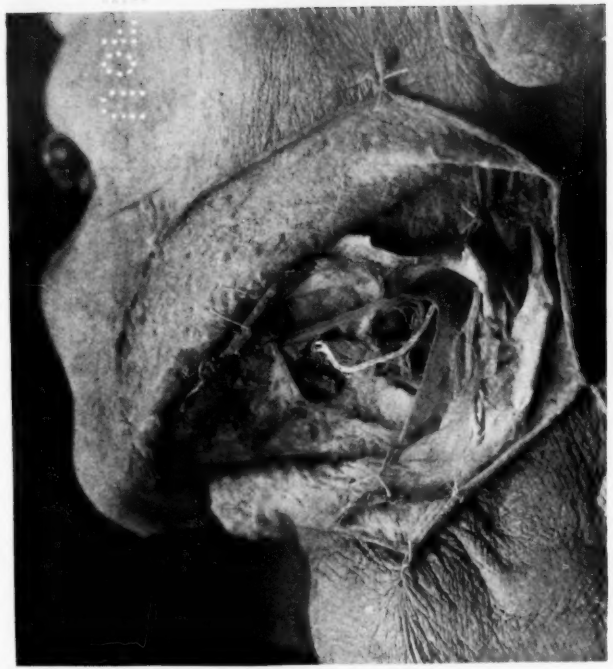
Paralysis of depressor labii inferioris (right) following extensive submaxillary dissection.

FIG. 2



Outline of inferior branches of the facial nerve. Scar of extensive dissection for tubercular nodes.

FIG. 3.



Submaxillary dissection. Deep fascia incised and retracted, exposing submaxillary branch and the salivary gland in its pocket in the deep fascia.

FIG. 4.

Tubercular submaxillary nodes just beneath the nerve.

FIG. 5.

Platysma turned upward. Deep fascia removed, exposing submaxillary branch and facial vessels, submaxillary nodes and salivary gland. Anastomosis between facial and cervical nerves.

FIG. 6.

Submaxillary branch to depressor muscles, transverse and descending branches to platysma. Deep cervical fascia turned downward.

ANÆSTHOL POISONING CAUSING ACUTE YELLOW ATROPHY OF LIVER AFTER OPERATION FOR ILEOCOLIC INTUSSUSCEPTION.*

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In the last few years cases of delayed chloroform poisoning have come to our notice from time to time. The main lesion in these cases has been acute yellow atrophy of the liver. In many of them there had been suppurative processes within the peritoneum, thus rendering it uncertain whether these suppurations or the chloroform were the cause of the acute yellow atrophy, inasmuch as that affection has also been observed after operations for intra-abdominal suppurative processes, where ether was used. The case I am about to describe is one in which that element of doubt is eliminated, as there was no suppurative process found at the operation, nor did any develop afterward, as the autopsy showed. This case therefore appears to be an uncomplicated instance of delayed chloroform poisoning.

Oscar S., druggist, aged thirty-six years, was admitted to the German Hospital on December 24, 1909. Three weeks before that date he had been attacked with severe paroxysmal pain in the right iliac fossa together with vomiting and diarrhœa. Appendicitis had been suspected at that time. The symptoms subsided soon and the patient went to work again. After a week or so the paroxysmal colicky pains recurred, but were slightly higher up, about corresponding to the region of the gall-bladder, and a mass was felt under the liver, so that this time cholecystitis was suspected. A day or two later he vomited several times, the vomitus containing biliary matter and at one time blood. The

* Read before the Clinical Society of the German Hospital and Dispensary, December, 1909.

stools also contained blood. At the same time the mass in the right hypochondrium was no longer felt, and the existence of a perforation of the gall-bladder into the duodenum was considered as a possibility. The patient improved in a few days and went to work again.

On December 24 he had a severe recurrence of his attack of pain, this time combined with constipation. Physical examination revealed resistance of the recti, more particularly the right. There was tenderness on pressure. A large sausage-shaped mass could be felt extending across the upper part of the abdomen; it seemed to change its shape somewhat with the attacks of pain. As the obstruction was evidently a chronic one, an attempt was made during the next two days to overcome it by high oil and soap enemata, but without avail. On December 27 an operation was performed. An ileocolic intussusception was found extending almost to the splenic flexure of the colon; but the left portion of the colon was drawn over toward the right side, so that the tumor lay more on the right side than on the left. Disinvagination was now proceeded with by gentle manipulations of expression begun at the left portion of the transverse colon and working from there to the right and then downward in the direction of the right iliac fossa. Good progress was made until a portion of the appendix came into view; here the intussusceptum was held firmly within the intussuscipiens by strong adhesions. By cutting these with the knife the intussusceptum could be released a little more; but then it was seen that the cæcum was partly gangrenous, and the attempt to disinvaginate further was given up. A lateral anastomosis was now made between the ileum and the transverse colon, followed by a resection of the cæcum with half the ascending colon and a small portion of ileum. The cut ends of the intestine were closed by inverting them, two rows of silk sutures being used.

The relief experienced by the patient was immediate; he expressed it by the remark that he felt as though he were in heaven. His temperature at the end of twenty-four hours was 102.8, his pulse 140, respiration 24. From this time on the temperature steadily declined; after forty-eight hours it had reached 99.8 and after that became normal. The pulse, however, remained high, around 120. During all this time the patient felt very well and looked well. In the morning of the third day the

patient became restless and would occasionally scream loudly. When asked, he could give no reason for his shrieking; but from his facial expression it was evident that in his imagination something must have badly frightened him. At this time slight jaundice appeared in his conjunctivæ. He soon became delirious, then stupor set in, and his breath assumed an acetone odor, so that now he had all the characteristic symptoms of acute yellow atrophy. A venesection was now made, followed by saline infusion, but without any effect on his condition. The stupor deepened into coma in which he died on the fourth day. Shortly before death the temperature had risen to 100.

The autopsy revealed an acute fatty degeneration of the liver. The surface of the liver was smooth, the capsule not wrinkled, the cut surface bright yellow with evenly mottled bright red spots; the interstitial tissue was not increased. The peripheral zones of lobules were represented by yellow material. The organ felt greasy and was doughy in consistency. The kidneys showed the signs of acute diffuse nephritis. The portions of intestine at the site of the operation were in good condition. There was no peritonitis with the exception of a slight local patch resulting in an adhesion of the omentum to the ileocolostomy (I had wrapped the omentum around that part, in order to make it adhere). The myocardium was flabby.

It will be seen that in all the characteristic points the history of this case corresponds closely with the histories of other cases of acute yellow atrophy that have been described, the apparent well-being in the first days, followed about the third or fourth day by jaundice, restlessness, delirium, acetone breath, stupor, and coma. In the absence of any suppurative process within the abdomen it is fair to assume that in this case the acute yellow atrophy was due to delayed chloroform poisoning, the deleterious action of the chloroform on the liver being enhanced by a congestion in the portal circulation caused by the intussusception. The existence of such congestion was evidenced by the fact that the patient vomited blood, although there was no lesion in the stomach or duodenum, as the autopsy showed.

The anæsthetic employed in this case was anæsthol, a fluid

the composition of which is about as follows: ethyl chloride 17 per cent., chloroform 35.9 per cent., ether 47.1 per cent.

Eggers (German Hospital "Festschrift") has also published a case of acute yellow atrophy after an operation during which anæsthol was employed for narcosis. It has long been known that ether is a safer anæsthetic than chloroform. When anæsthol was brought out, it was believed by some that the danger of chloroform had been removed by this new combination. But we have seen deaths on the operating table where anæsthol had been given, and the cases reported by Eggers and myself show that one of the remoter results of chloroform poisoning will also not be avoided by using anæsthol. It seems therefore that, in estimating anæsthetics from the viewpoint of danger, a narcosis with anæsthol should be considered as being a chloroform narcosis.

THE SURGICAL ASPECT OF EPULIS AND SARCOMA OF THE JAW.*

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THERE are many conditions of the jaw the pathology of which differs to such an extent that surgical measures must depend necessarily upon the characteristics of the tumors or diseases in question. The relationship which exists between the class of growths termed in a broad sense "epulis" and other more malignant tumors is an important one. In this paper, attention will be directed only to the connective-tissue tumors of the jaw, and those derived from epithelial structures or the conditions due to faulty development of the teeth will not be considered.

The term epulis signifies a tumor springing from the gums, and although the word has been condemned justly because of the confusion its use has entailed, it has become nevertheless so thoroughly a part of the nomenclature of jaw tumors that it cannot be excluded. Probably the greatest difficulty has been experienced in keeping clear the relationship of the highly malignant sarcomata which, springing from the deep tissues of the jaw, pursue a more unfavorable course than the relatively benign sarcomatous epulides. It becomes necessary, therefore, to properly understand such distinctions in order to describe the varieties of epulides and the sarcomata.

Epulis was used originally to describe any tumor which had its origin in the tissues of the alveolar process of the jaws, the term being used independently of the pathologic type of tumor. Thus carcinoma, sarcoma, and various benign tumors,

* Read before the Philadelphia Academy of Surgery, April 4, 1910.

such as myxoma, chondroma, fibroma, etc., were included. The tendency in more recent times has been to describe as an epulis only the sarcomatous and fibromatous tumors originating on the alveolar margin, and to designate the other tumors in this region by their true pathologic name. Because of their less malignant tendency, the sarcomatous forms of epulis are thus properly excluded from other more dangerous forms of sarcoma, but the term "epulis sarcoma" or "epulis fibroma" should be employed rather than simply to use the vague term "epulis." It is particularly desirable to separate from the epulides the carcinomatous type which is occasionally encountered, because it presents altogether a different clinical course from the sarcomatous epulis.

The histologic examination of collected cases of epulis shows a varied picture. Kühner, in his series of 31 cases, found 20 giant-cell sarcomata, 2 spindle-cell sarcomata, 4 fibrosarcomata, 2 fibromata, 1 osteoma, and 1 granuloma. The proportion of giant-cell sarcoma, about two--thirds of all the cases, corresponds to the observations of most writers. Hesse in a recent contribution, however, has disputed these facts, for he found that of 113 cases of epulis, 30 were sarcomatous, and by far the most common form encountered was fibrous in nature. This difference is explained by the fact that the majority of these cases were seen in a dental clinic, where the small and painless tumors are most commonly encountered, whereas the more rapidly growing and consequently more malignant forms are usually referred to the surgical clinics.

Histologically, giant-cells are found in enormous numbers in the majority of cases, the chief constituent of the tumor being composed of spindle- or round-cells. The tumors contain considerable blood pigment and extravasated blood, and at times are quite vascular, thus explaining their brownish-red color. Spicules of bone are common constituents of the growth, a fact which indicates that the bone-forming layer of the periosteum is involved in the growth of the tumor. An epulis occasionally arises from the submucous connective tis-

sues, or in the peripheral layers of the alveolar process, and by growing externally appears beneath the mucosa.

The sarcomatous epulis is a pedunculated tumor, dark red in color, more or less movable, and may cause distortion in the outline of the teeth as it enlarges. The mucosa covering the tumor is intact in the early stages, but sooner or later shows points of erosion due to local traumatism, from which slight hemorrhage may occur. The tumors are usually soft in consistency, but may be firm and hard when of the fibrous or the fibrosarcomatous type.

The statistical studies of Kühner, Gunzert, and others, show a marked predisposition of the female sex, in whom two-thirds of the cases occur. While the disease may be seen at any time of life, it is most commonly encountered in the second, third, and fourth decades, although it is not uncommon in younger and older individuals.

Among the factors chiefly concerned in the etiology of epulis, caries of the teeth may be mentioned as the most prominent. The irritation of ragged, irregular, diseased teeth plays an important rôle in the formation of these growths, and such a history will be obtained from the majority of patients. In the instances in which extraction of a diseased tooth has been followed by the formation of a tumor, it is likely that the traumatism was sufficient to cause active growth of cells left behind after the removal of the tooth. This is especially likely when we bear in mind the tendency of the tissues of the mouth, the mucosa and the periosteum of the alveolar process to react to any sort of irritation. It should be mentioned, however, that epulides occur in the presence of sound teeth and under proper oral hygiene, neglect of which seems to act as a predisposition to the formation of the tumors. The influence of pregnancy in the development of an epulis has been repeatedly mentioned; the association, while difficult to explain, seems to be more than a mere coincidence. Finally the effect of artificial teeth, the irritation of pipe smoking, and other forms of long-continued traumatism may be mentioned as possibly having some etiological importance.

Clinically the tumors rarely cause serious symptoms. The jaw may be infiltrated in the late stages of the disease and absorption of the cortex arise; it may extend to the antrum or nasal cavities, displace the tongue, or cause protrusion of the lips. In the very large tumors, difficulty in chewing, swallowing, and speaking may be caused. Pain, which at times is complained of, is due to the diseased condition of the teeth. Repeated traumatism may cause hemorrhage from the more vascular growths, which in time may cause a moderate degree of anæmia. The ulcerative condition of the gingival mucosa may play a rôle in causing more rapid enlargement of the epulis.

The benignancy of this class of neoplasm is well demonstrated by the fact that metastasis to the regional lymph-nodes occurs practically in advanced cases only. The enlarged nodes seen in the course of an epulis are usually of inflammatory origin, and are caused by infection absorbed from carious teeth. In many instances the nodes disappear after extirpation of the tumor, and in those cases in which the enlarged lymphatics were removed with the tumor, microscopic examination has failed to reveal malignancy in the nodes.

The tumor generally exists for a considerable period before operative intervention is carried out; in most instances a year or more may elapse until rapid enlargement of the epulis causes the patient to seek surgical aid. Perthes is inclined to place little weight in the view that the giant-cell tumors are less rapid in their growth, because he has observed cases of the same histologic character, in which marked difference in rapidity of the enlargement has been present.

It is a well-known fact, that whereas epulis is a tumor benign in nature from the clinical stand-point, it tends to recur when insufficiently removed, and in such cases the recurrent tumor may take on a more rapid growth. Kühner records 11 recurrences in 90 cases of epulis—the operation in this series removed only the visible tumor tissue and not the portion of the alveolar process from which it sprang. If secondary operations are carried out promptly, the chance of ultimate

cure is good, for instances are on record in which repeated operations have finally resulted in a cure.

That the prognosis is good is shown in the very large percentage of cures which ranges from 75 to 97 per cent. An important observation was carried out by Kühner in four of the cases not undergoing operation for the radical removal of the epulis. He found that three died from the effect of the tumor, one of general sarcomatosis; the second, a man fifty-four years of age, of extensive recurrence; and the third, a male aged sixty-six, from blood poisoning originating in the epulis. In the fourth case, a boy aged five, spontaneous healing occurred and persisted for a period of 25 years. From these cases and similar observations, it is apparent that epulis, if neglected, may become highly malignant, and resemble in this particular the sarcomatous growths of the jaw.

Fibroma.—This affection appears as a central growth, or it may arise from the periosteum and appear as an epulis of the fibrous type. The growth has many of the characteristics of the sarcomatous epulis, but appears harder and more compact, owing to the large amount of fibrous tissue in its structure, which accounts for its lighter color. In some instances the cells of the tumor are so abundant that the growth is quite soft, resembling a sarcomatous epulis for which it is mistaken at times. Eve holds the opinion that most of the so-called fibrous epulides are sarcomata, for in his series of cases a pure fibrous epulis did not exist. This, however, does not correspond with other observations; I have studied two cases in which there was no evidence of sarcomatous tissue in growths which were classified as fibrous epulides. Gunzert described myxomatous degeneration of the tissues which is particularly prone to arise in the tumors of long standing. The base of the epulis may contain lime salts or spicules of bone. While the tumors are usually small, they at times reach a large size and are dangerous from a mechanical stand-point. Sudden enlargement is indicative of a malignant degeneration, *i.e.*, sarcoma. Perthes calls attention to the tendency of the fibrous epulis to appear as multiple growths affecting both jaws.

The central variety of fibroma differs as greatly from the fibrous epulis as does sarcoma from a sarcomatous epulis. The growth, according to Perthes, may occur in either jaw, but is more common in the lower. The tumor takes its origin from the central part of the bone, and as it grows the periosteum and cortex become expanded over it, forming a thin shell, or the rapidly growing tumor may be covered with a layer of tissue containing bone trabeculæ derived from the periosteum. The tumor may be firmly attached to the bone covering it or lie free in the cavity. When seen in the upper jaw, the tumor tends to spread toward the antrum, or may arise primarily in that situation.

The growth of a fibrous epulis is essentially a slow one, it may occupy many years in its development, and most commonly occurs in the third and fourth decades of life. The enlargement does not, as a rule, produce pain unless pressure is exerted upon nerves, as, for example, infra-orbital neuralgia may occur in the fibromata of the upper jaw. There is no tendency of the tumors to metastasize, ulcerate, or infiltrate the surrounding tissues, all of which point to its benign nature. Secondary infection and necrosis have followed exploratory incision in a fatal case recorded by Heath.

The diagnosis depends largely upon the gradual growth and painless course of the fibroma. If the tumor is attached to the lower jaw, distending it, and if surrounded by a shell of bone, the differential diagnosis between it and other benign growths will be difficult, and may only be made by aid of a Röntgen examination. The differential diagnosis may also be difficult in slowly growing myxosarcomas in the same location.

The operative measures in these cases demand complete removal of the tumor and the portion of bone to which it is attached. Only in exceptional cases will it be necessary to do total resection, and then only when the size of the growth prevents less radical measures. Following partial resection of the jaw and the tumor, the results have been satisfactory, since the benign nature of the fibroma excludes the possibility of a recurrence.

Sarcoma.—Sarcoma of the jaw occurs less frequently than carcinoma, the proportion being about two cases to the former to three of the latter. The relative frequency of sarcoma of the jaw is shown by Gurlt's statistics in which 14,630 tumors included 532 growths of the jaw, and of the latter 179 were sarcomata, 96 occurring in the upper jaw and 63 in the lower. From these statistics and other observations, the upper jaw is found to be the more common site of the tumor. As already noted in the sarcomatous epulis, the female sex is more often affected; the same relative proportion is observed in the jaw sarcoma. In Perthes's collected statistics of 126 cases, 55 were men and 71 were women.

Trauma seems to play an important rôle in the etiology of sarcoma. Whether the effect of injury is manifested by the stimulation of tumor cells already present, or whether the trauma is even more intimately concerned in the origin of the growth, is difficult to prove. The cases which I have studied show in several instances that trauma played a part in the development of the tumor. In one instance a very large sarcoma began its initial growth several months after the extraction of two teeth and reached its maximum size in eight years. It is possible in this case that the effect of trauma was manifested by increased rapidity in growth of cells, which were present at the site of the diseased teeth, but which were more or less inactive previous to the traumatism. In another instance, a boy aged twenty-two was injured while boxing, and several of the lower teeth were loosened. After this accident tenderness was present for several months, and then swelling of the jaw arose. This condition lasted for three years, when rapid enlargement took place, so that four years after his accident a definite mass the size of a hickory-nut projected from the middle of the ramus of the lower jaw. This tumor and the adjacent portion of the jaw were removed by Dr. C. H. Frazier, and on microscopic examination was found to be an osteosarcoma of a low degree of malignancy.

Histologically all varieties of sarcoma occur and follow the general rule that the smaller and more abundant the cells,

the greater the degree of malignancy, as manifested by rapidity of growth, metastasis, and tendency to recurrence. The giant-cell sarcomata are the least malignant and resemble the tumors of similar structure found in other bones in respect to their slow and relatively benign course. In contrast to the simple forms of sarcoma, those in which cells of the original embryological jaw structure are reproduced present a more varied picture. Thus chondrosarcoma, fibrosarcoma, and osteosarcoma are met with, all of which possess a greater or less degree of malignancy, depending upon the number and size of the sarcomatous elements.

A curious tendency of the last named type lies in the formation of highly malignant secondary growths composed of pure sarcomatous tissue, in which the bone or cartilage may not be reproduced. In general it can be said that sarcoma of the jaw has but a slight tendency to metastasize to the regional lymphatics draining the area and tends still less to spread to the viscera. Enlargement of the cervical nodes may be present, but in many instances it is the result of infection rather than a secondary tumor formation. It is not an uncommon experience to see enlarged nodes disappear after the jaw tumor is excised, although it is a safer and more scientific surgical principle to remove enlarged nodes, as in any radical operation for the cure of a malignant tumor.

The symptoms produced by the peripheral form of sarcoma differ somewhat from the central variety. The latter tends to produce more or less hard, rounded, circumscribed tumors which generally enlarge toward the outer surface, and may be mistaken for dentigerous cysts. Later in the course of the growth, the cortical layers of the compact bone become rarefied, and the crackling sensation common to central sarcoma of bone may be produced. As the tumors enlarge, pressure symptoms develop, thus œdema of the eyelid and mucous membrane of the antrum, dislocation of the eyes or teeth, dilatation of the superficial facial veins, obstruction of the nasal duct, and difficulty in speaking and swallowing may occur. The periosteal tumors present a somewhat different picture,

in that the shape of the growth varies, it takes its origin directly from the periosteal covering of the jaw, a fact easily demonstrable on palpation. In the early stages the mucosa is intact, the growth is painless until it undergoes ulceration or the infiltration of the bone causes pain. Pain is also seen in the neoplasms which press upon nerves. Neuralgic conditions of the teeth may arise and direct attention to the cause, a beginning sarcoma.

The operative indications of jaw sarcomata depend on the histologic type of tumor and the extent of the growth. Perthes's statistics based upon the results obtained in several clinics lead us to conclude that, after a period of three years, a third of the cases of total resection of the jaw for sarcoma will remain well. One-half of the patients develop recurrence, a fact which demands still more radical measures in treating these cases. It must be stated, however, that partial resection of the jaw has met with considerable success, but too great emphasis cannot be laid upon the class of cases for which this operation is indicated. The small, well-circumscribed, giant-cell sarcomata situated on the alveolar margin of the upper jaw, irrespective of epulis, and sarcoma of the hard palate may be partially resected. Similar growths on the alveolar process of the lower jaw may be treated in the same way, but all other forms of sarcoma should be subjected to total resection. The percentage of cures in these cases will increase if we operate at an earlier period, before the growth has involved a large area of the bone. The slight tendency toward regional or general metastasis should prove of great value in favoring early operation, and markedly assist in cure because of the lessened possibility of recurrence.

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THE USE OF DIFFERENTIAL PRESSURE IN THE TREATMENT OF EMPYEMA.*

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As the bar to progress in thoracic surgery has been the danger of lung collapse, clinical advance in this field has awaited the invention of a certain and practical means of preventing pneumothorax. This difficulty is now overcome,

FIG. 1.

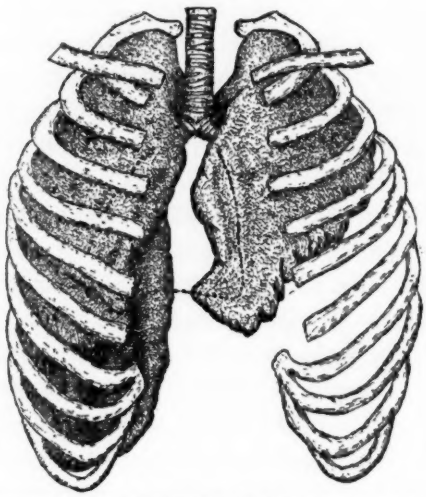


Diagram showing pressure effects of pleuritic effusion upon the respiratory viscera and mediastinal structures.

and there are already well-recognized procedures in which the use of differential pressure is a necessary part of the technic. Among such, one might mention the removal of tumors of the thoracic wall, pleura, and lung; exploration of the pleural cavity for foreign bodies; excision of the whole or part of a lobe for bronchiectasis; and gastro-œsophagostomy for malignant disease of the cardia or benign or malignant stricture of

* Read before the Canadian Medical Association at Toronto, June, 1910.

the lower extremity of the œsophagus. The widest field, however, for the application of differential pressure is found in the treatment of empyema, where, by its means and by the application of a suitable dressing after thoracotomy, the period of disability may be very greatly curtailed. At the time of operation and at subsequent dressings, positive differential is especially suitable, as with a portable apparatus not only hospital cases but also cases operated upon in private homes may enjoy the benefit of this method of treatment.

FIG. 2.

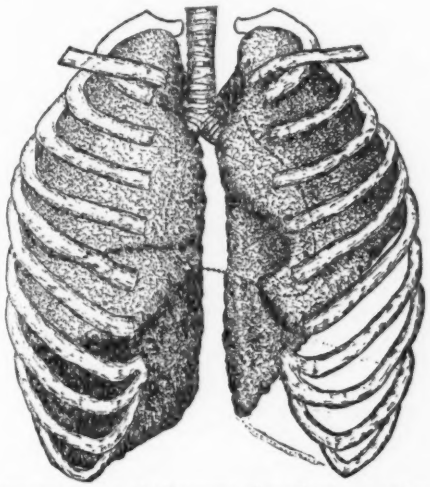
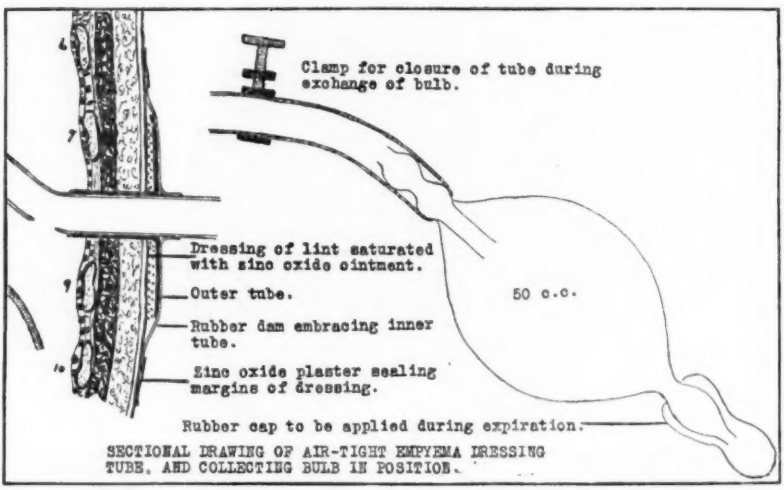


Diagram showing correction of alignment of mediastinum and restoration of normal contour of lung on the unaffected side under differential pressure and in the presence of thoracotomy. The lung on the affected side also shows a slight increase in volume.

The accompanying illustrations convey graphically the effects of differential pressure in the treatment of empyema (Figs. 1 and 2). Following thoracotomy an empyemic cavity remains exposed to atmospheric pressure. In extensive cases the whole lung may be collapsed and may lie in close apposition with the mediastinum. Further, the mediastinum and pericardium are not infrequently displaced toward the sound lung. Under such conditions, each inspiratory act results in the deflection of the mediastinal septum and collapsed lung toward the sound side, in response to the negative tension produced on that side during inspiration. On consideration, it is quite evi-

dent that the mediastinum and exposed viscera must tend to move away from the cavity so long as the tension within the cavity remains greater than the average intrapulmonic tension. This fact partially explains why, in long-standing cases, the collapsed lung fails to regain to any extent its functional activity. In these cases the empyemic cavity is eventually obliterated by the formation of scar tissue within, and through its contraction, the approximation of the various anatomical structures forming the boundaries of the cavity, that is the mediastinum, the diaphragm, and the chest wall. We are all

FIG. 3.


Clamp for closure of tube during exchange of bulb.
Dressing of lint saturated with zinc oxide ointment.
Outer tube.
Rubber dam embracing inner tube.
Zinc oxide plaster sealing margins of dressing.
50 c.c.
Rubber cap to be applied during expiration.

SECTIONAL DRAWING OF AIR-TIGHT EMPYEMA DRESSING TUBE, AND COLLECTING BULB IN POSITION.

familiar with the resulting deformity. In the fact that the mediastinum tends to oscillate towards the sound lung during inspiration, we have the explanation of the cyanosis and rapid respiration so frequently present after thoracotomy for empyema. An inspiratory deflection of the mediastinum toward the sound lung must necessarily nullify, in direct proportion to its degree, the end result of inspiration by lessening the area and amplitude of infundibular inflation.

With the use of differential pressure and the application of an air-tight dressing, such as the one which I have devised (Figs. 3 and 4), not only is the mediastinal deflection reduced

FIG. 4.

Photograph of case showing air-tight dressing, tube, and collecting bulb *in situ*. This case, one of pyopneumothorax in a girl aged fifteen years, presented complete collapse of the left lung of eight days' duration. The bronchial communication had closed at the time of operation, and while hypertensi n (15 mm Hg) corrected the mediastinal deflection, it failed to expand the lower lobe. Obliteration of this large cavity was effected under constant negative tension in twenty days through expansion of the upper lobe and approximation of the mediastinum, diaphragm and chest wall,—the lower lobe remaining in an atelectatic condition.

and the cavity thereby diminished in size, but the air within the abscess cavity becomes negative in tension during inspiration, and, in consequence, the mediastinum and pericardium tend to be further deflected toward the cavity and the collapsed lung to expand in the same direction. An immediate result of such a method of treatment is the prompt relief of the cyanosis. Subsequently, day by day, there is an appreciable diminution in the size of the cavity. Not only does this dressing do away with the foul odor in the sick room, but as will be seen by the chart, the amount of discharge may be accurately tabulated.

FIG. 5.

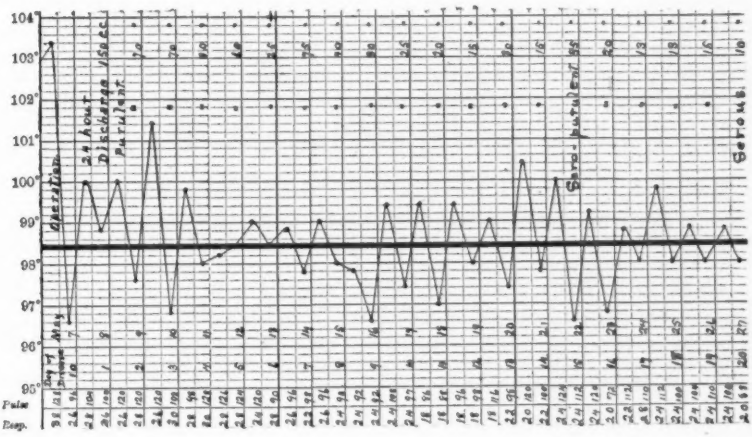


Chart from case (Fig. 4) of pyopneumothorax, showing the daily amount of discharge.

The collecting bulb in this way becomes an instrument of precision. If the discharge shows a gradual decrease and the temperature remains normal, one may be satisfied that there is no pocketing or retention of pus. On the other hand, if there is a rise in the temperature curve, a definite knowledge of what the amount of the discharge should be may give one a clue to the cause. Apart from the curtailment of the period of disability, the absence of odor and of the pain and discomfort of prolonged dressings, the earlier restoration of the collapsed lung to its normal respiratory activity may remove to a large extent the danger of a subsequent tuberculous infection.

PRIMARY SARCOMA OF THE STOMACH.

WITH REPORT OF TWO CASES.

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AND

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THE interest of these two cases centres, first, in the fact that they are examples of a comparatively rare type of disease; second, that they presented symptoms of marked disagreement; and, third, that neither gave indications sufficiently suggestive of the pathological lesions existent. Without further comment, the history of each case will be first given.

CASE I.—Miss A. P., aged fifty-seven years, a teacher by profession, was seen in consultation with a local practitioner. The case was considered probably one of a large ovarian cyst, and the patient was accordingly removed to a private nursing home for operation. She was admitted in October, 1909. She had always enjoyed good health, and with the exception that she had recently suffered from occasional attacks of frequency of micturition, her only complaint was one of increasing discomfort from enlargement of the abdomen. She was perfectly clear and emphatic regarding the entire absence of any gastric symptoms, and being a particularly intelligent lady such a statement may be regarded as possessing the truth. Menstruation had ceased two years previously. Prior to that her periods had been regular and normal, accompanied only with some pain on the first day. Since the menopause there had been no symptoms referable to the uterus. Her previous history was free from any disturbances of a local or constitutional character. The lower part of the abdomen was very prominent, and a large swelling could be felt filling the hypogastric and

lower umbilical regions with a leaning towards the right flank. The tumor felt quite smooth on the surface and appeared movable. There was no indication of fluctuation. Pressure caused no pain, nor from the regularity of her bowels did it seem to have any obstructive effect upon the intestines. Both flanks were resonant. An examination *per vaginam* revealed a small but freely movable uterus; both fornices were empty, and the tumor seemed to be entirely without the pelvic cavity.

The abdomen was opened by a curved incision below the umbilicus. A smooth rounded tumor was at once encountered presenting a somewhat dark mottled and striped appearance. The hand introduced into the abdomen felt a nodular projection at the upper part, with attachments below to the omentum and above to the stomach. The growth was felt to be free from any connections with the pelvic viscera. A small median incision carried upwards permitted the tumor to be brought out. After tying off the few omental adhesions, the growth was then discovered to be united by a solid pedicle, about the diameter of the thumb, to the greater curvature of the stomach some two inches or so from the pylorus. The part of the gastric parietes involved was excised, and the aperture closed by a double row of sutures. The patient made an uninterrupted recovery.

The specimen when examined after removal was found to be a large unilocular cystic tumor with smooth external wall, and filled with laminated clot. It measured 14 x 14 x 11½ cm., and was adherent to the wall of the stomach. A portion of the stomach wall with tumor tissue invading it, of the size of a walnut, was also submitted for examination, and on section presented a somewhat gelatinous appearance with healthy-looking mucosa covering it. Section of the wall of the cyst showed, under a low power, a fibrous stroma supporting a cellular element. In parts of the section the structure was of a somewhat loose character; in others more dense and cellular. At the periphery the fibrous character was more apparent, and the outer part of the tumor area had an appearance not unlike that of a spindle-celled sarcoma. In the central part of the section thin-walled congested vessels were fairly abundant, and extravasations of red blood-corpuscles were also apparent. Spaces resembling fat cells were also seen in the section. With the high power the characters of the cells which composed the tumor

were found to fall into two groups—cells of connective-tissue origin, fibroplastic and definitely spindle in shape; and larger cells of spherical shape with sharply staining nucleus and a large protoplasmic body deficient in chromatin. Well-formed blood-vessels were present in the section, and in a few places small nodules of lymphoid cells were also present. The characters of the section would suggest a tumor of mesoblastic origin, viz., a mesothelioma. Microscopic examination of the stomach wall showed that the mucous membrane and submucous layers were unaffected by the tumor involvement, but the muscular wall showed extensive infiltration. Areas of tumor cells extended between the muscular bundles, and in parts replaced them. Under the high power the same character of cells was noticed as above described in the cyst wall, but the larger spherical cells were more abundant.

Case II.—R. H., aged sixty-three years, was admitted to the Victoria Infirmary in July, 1903, suffering from a tuberculous stricture of the rectum. At this time there were no gastric symptoms, his trouble being entirely referable to the rectum. The stricture was successfully excised, and he remained well for some years. He then began to be troubled with prolapse of the rectum and some incontinence of fæces. For this he was again admitted to the Infirmary in September, 1909, *i.e.*, six years after his first admission. During this period of residence he complained of very distinct gastric symptoms—he had a distaste for food and felt occasional pain in the epigastrium; the latter, however, seemed to have no association with the ingestion of food. He did not vomit, nor did he feel any inclination to do so. There was no tenderness in palpating the epigastrium, nor could anything be felt; he was, however, quite definite and positive in his statement that a lump occasionally appeared on the "left side of his belly" just below the costal margin. As the condition of the bowel was solely under consideration, the gastric symptoms did not receive the amount of attention they deserved. He was in a very low and enfeebled state of health, and succumbed after the operation attempted to relieve the prolapse. A postmortem was obtained, when the following conditions in connection with the stomach were found:

Adherent to the stomach was a large cystic tumor, somewhat larger in size than a child's head, springing from the greater

curvature of the stomach, with smooth external wall, unilocular, filled with blood-stained fluid, and soft tumor tissue resembling in appearance partly organized blood-clot. The mucosa was healthy. The microscopical examination of the tumor showed its character to be that of a spindle-celled sarcoma, fairly dense in consistency. Throughout the section were noted a number of new-formed thin-walled vessels filled with blood, and in parts extravasations of blood were seen. The section through the stomach wall showed tumor infiltration of the serous and muscular coats. The mucosa was found uninvolved. There were no evidences of tumor formation in any other part of the body.

Remarks by Mr. Maylard.—Primary sarcoma of the stomach, as judged by recorded cases, seems a very rare disease, and more particularly so if the pyloric region be excluded. In other words, cases such as those just described, of well-defined and distinct non-ulcerative growths springing from the mid-gastric parietes, are extremely exceptional. Probably one of the earliest recorded cases, or, at least, one of the earliest successful cases of removal of a tumor of this nature from the stomach, is that of Billroth's in 1881. Since then isolated cases have from time to time been reported, and if foreign records be excluded, very few have been published in the English language. In the past they appear to have been more frequently met with in the post-mortem room than in the operating theatre; and a really correct appreciation of the frequency of the disease, therefore, could only be obtained by a combined investigation of surgical and pathological records. There are two published cases which I will refer to more particularly, because in certain points they markedly resemble my own. In one, recorded by Hartley (ANNALS OF SURGERY, vol. xxiii, 1896, p. 609), the tumor was a spindle-celled sarcoma, like, therefore, my second case. In the other, recorded by Cantwell (ANNALS OF SURGERY, vol. xxx, 1899, p. 596), the clinical resemblance to my first case was most striking; in neither were there any symptoms attributable to the stomach, indeed, the sole complaint made by each was the increasing discomfort engendered by the abdominal distention. Strangely, also, a

further agreement existed in the fact that in both instances it was thought likely that the tumor was connected with the genital organs. I must own that no other thought entered my head; for although a vaginal examination showed the pelvic organs free, it simply left the impression that the supposed ovarian cystoma had swung itself free of the cavity of the pelvis. We were further misled by the patient's statement that she first noticed the swelling in the right flank. It must be deemed a remarkable fact, as much in my own case as in that of Cantwell's, that such large tumors could hang from the gastric parietes without interfering with the normal functions of the viscus and causing some sort of dyspeptic symptoms.

Remarks by Dr. Anderson.—Both the tumors presented a marked similarity in their external appearances, being cystic in character and covered by a smooth external peritoneal lining, and both springing by a definite pedicle from the wall of the stomach, the mucosa of which in both cases was uninvolved. The second case presented the definite microscopical appearances of a spindle-celled sarcoma; the first case, on the other hand, showed the presence of characters of a spindle-celled sarcoma and endothelioma in different parts. The following quotation from a paper upon the subject by MacCormick and Welsh (*Australasian Medical Gazette,* July 20, 1906) is of interest. These authors state: "It is sometimes hard to decide whether the growth has started in the stomach or has taken its origin in some adjacent structure. In the case of the spindle-celled sarcomata, they rarely present this difficulty of interpretation, and their origin in the submucosa is more generally accepted. They commonly take the form of localized growths which sooner or later project from the outer surface of the stomach, and when, as so often happens, they grow from the posterior wall, they pass into the lesser sac of the peritoneum, which they may come to distend. As they increase in size, they frequently become pedunculated and may form adhesions to adjacent structures."

It is in connection with the first case, in which both spindle

and endothelial cells are present, that the difficulty arises. I described it in the account of one section as a mesothelioma, and from this I infer that it had its origin in or beneath the serous coat. Similar difficulties in reviewing the tumors of the round-celled sarcomata group have been experienced by the above-named authors; but here the question was whether the case was a primary sarcoma or secondary infiltration of the stomach wall of the nature of that seen in lymphocythæmia. But the clinical history and present satisfactory condition of the patient are more in favor of the opinion I have expressed.

THE FUNCTION OF THE APPENDIX AND THE ORIGIN OF APPENDICITIS.

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SHORTLY after his death, a paper was published in the ANNALS OF SURGERY by Mr. C. B. Keetley about the function and value of the appendix. Both he and Sir William Macewen regard the appendix as a valuable actively useful organ not to be sacrificed lightly. Their opinions are based largely upon complicated clinical observations. Other observers, such as Mr. W. J. Mayo, incline to the other extreme: that the value and functions of the appendix are so small that they are absolutely inconsiderable when compared to the dangers which it may cause. When the enormous number of people are considered who have had their appendices removed and are in perfect health, one cannot but sympathize with the latter view put forward. Yet as a matter of scientific interest, the appendix has a function; and, when diseased and removed, that function is undertaken by neighboring tissue and the patient is relieved of a passive tube containing actively poisonous material. Such a view I advocated in the Erasmus Wilson Lectures delivered before the Royal College of Surgeons in 1904 [1] and, in view of Mr. Keetley's recent death, shall content myself with restating them. This is done in four sections: the natural history of the ileocæcal region, the physiology of the appendix, the development of the appendix, and the pathology of chronic typhlitis and appendicitis.

THE NATURAL HISTORY OF THE ILEOCÆCAL REGION.

Food in the mouth is reduced by the action of the teeth to a more or less pulpy condition, in which state it enters the

[1] "Clinical and Pathological Observations in Acute Abdominal Disease" (Constable & Co.), 1904.

stomach, where it is further broken into fragments by the action of the hydrochloric acid, pepsin, and churning muscular movements. The casein of our primitive natural food, milk, is precipitated and also fragmented. The pylorus, the smallest portion of the alimentary canal, allows or should allow no large pieces to pass into the duodenum. The work of the stomach and mouth may be regarded as chiefly, if not entirely, preparatory to chemical digestion and absorption, and to partake of the physical nature of fragmentating the food. The more perfect the work of the stomach, the more completely will the food be reduced to a molecular condition, and consequently, the more perfectly will it be adapted for the chemical action of the bile and pancreatic secretions. The next twenty odd feet of the small intestine are given over to these chemical changes and the absorption of nutriment. The products of digestion having reached the ileocæcal valve, it is the duty of that sphincter only to allow water, soluble material, and very small pieces of indigestible débris to enter the cæcum. There are similarities in the physiologies, *i.e.*, homologies, between the pylorus and the ileocæcal valve. The former is the portal between fragmentation on the one hand and chemical digestion on the other; the latter stands between chemical digestion and specialized absorption on the one hand, and possibly excretion, and the absorption of water on the other.

Fluid or semifluid material is passed from the small intestine through the ileocæcal valve into the cæcum. The latter is not adapted for the carriage of fluid by peristalsis; it is too large and thin walled to contract efficiently, unless it is tightly distended like the bulb of a Higginson's syringe. In addition, in man, gravity works against it. As a result the fæces must remain in the cæcum until the absorption of water from them and the addition of mucus to them have rendered them of the proper consistency for their transit along the large intestine. Hence, it is easy to understand why the cæcum is so often the most capacious part of the large bowel, and why at operations, particularly for intestinal obstruction, surgeons so frequently find it distended out of all proportion to the rest of the alimentary canal, the bowels being full of fluid.

Hence, just as there is a natural pause for food in the stomach, so is there another for the products of digestion in the cæcum; and in both, the contents are prepared for their course in the next part of the alimentary tract. To turn to the pathological significance of this halt, pause, or rest, it will be seen at once that the cæcum is the breeding ground of bacteria, par excellence, of all parts of our intestine. The enumerations of the colonies from different parts of the alimentary tract bear this out, and have proved that colonies of bacteria are more frequent by hundreds and thousands here than in any other part of the intestinal tract, even after a period of starvation. And it is only to be expected that this difference will show manifold increase when food is taken. It is now very easy to understand why nature has established so large a storehouse of protective lymphoid tissue for the production of leucocytes in the ileocæcal region, to which the appendix is an intestinal "tonsil," an index of the fermentative processes which are going on within the cæcum, a culture tube for the bacteria therein contained. Hence the very great frequency of its inflammation—appendicitis.

It will now be seen that there is strife between the microorganisms and lymphoid tissue in the cæca of every one. Hence the gradual disappearance of the lymphoid tissue as age advances. If the strife becomes a little more severe than it is ordinarily in health, some inflammation about the ileocæcal region will result, as after a dietetic indiscretion. In the great majority of cases, this inflammation shows itself as appendicitis. In consequence, appendicitis may be regarded as a result of the exaggeration of a process natural to the ileocæcal region of all.

THE PHYSIOLOGY OF THE APPENDIX.

It has long been taught that this organ was functionless, and that most probably in this lay its apparent incapability to resist the attacks of disease. That it represents the terminal portion of the cæcum which has become differentiated in development is undeniable, but that it is functionless is undoubt-

edly untrue. Like the rest of the intestinal mucous membrane, that of the appendix has numerous glands whose secretion has apparently an insignificant digestive action on all foods. As little if any contents of the cæcum ever enter the appendix, any digestive action it has must be of the smallest, and its absorption of products of digestion cannot be greater.

To sum up this phase of intestinal physiology: in the small intestine the products of digestion are fluid and are being continuously passed onwards by peristalsis; the cæcum is the first great "resting place" for these products since they have left the stomach; the large intestine, as its name implies, is of greater calibre than the small and is more suited for the carriage by peristalsis of solid than liquid fæces; the cæcum being rendered less mobile owing to its peritoneal attachments and, in man, having to work semifluid material against gravity, the products of digestion have to remain in it until their consistence has become such as allows of their passage along the large intestine; the change in consistence is made by the deposit of mucus from the glands of the large intestine and by the absorption of water. In consequence, the cæcum of the child loses its tapering form and becomes larger by the development of pouches between the tæniæ muscularis. During this "pause" further quantities of digested material will be deposited in the cæcum and dilate that structure, possibly delaying the despatch of the first "fecal" contribution. Hand in hand with these processes will go the fermentative changes of myriads of micro-organisms, to whom the temporary stagnation offers opportunity of multiplication. Hence the far greater quantity of bacteria in the large than in the small intestine. The temporary delay in the passage of the intestinal contents, the absence of a secretion like that of the stomach, the presence of large quantities of active micro-organisms and their products point to the necessity for the development of a protective armament on the part of the host to counteract them. Hence the large development of lymphoid tissue in the terminal and most dependent part of the cæcum, *i.e.*, the appendix, and its specialization not degeneration. The need

of the presence of this "intestinal tonsil" is apparent in the cæcal region. The comparative absence of lymphoid tissue in the rest of the large intestine is explicable, as it is in the cæcum that the fæces have been brought up to the proper consistence to allow of their passage along the colon, and in consequence there are no more prolonged periods of "rest" in the presence of moisture, the fæces becoming dryer and harder; consequently there will be less fermentative action.

Hence it may be said that: (*a*) Lymphoid tissue is the characteristic feature of the cæcal apex. The vermiform appendix of man is represented in the vertebrate kingdom by a mass of lymphoid tissue, situated most frequently at the cæcal apex. (*b*) As the vertebrate scale is ascended, this lymphoid tissue tends to be collected together into a specially differentiated portion of the intestinal canal, the vermiform appendix. (*c*) The vermiform appendix of man is not, therefore, solely a vestigial structure, though it undoubtedly represents the terminal part of the cæcum. On the contrary, it is a specialized part of the alimentary canal, nature having made use of a disappearing structure and endowed it with a secondary function by giving it lymphoid tissue to protect the body against the micro-organisms in the ileocæcal region.

DEVELOPMENT AND LIFE HISTORY OF THE APPENDIX.

The development of this organ illustrates the previous contentions and can be studied both in the individual, ontogeny, and in the animal series, phyllogeny. That of the human fœtus will be given first.

Up to the third month of intra-uterine life the diverticulum of the primitive intestine, which subsequently becomes the cæcum, is of uniform calibre throughout. At this period its growth becomes unequal, the terminal portion failing to increase in size at the same rate as the proximal. The inequality thus established becomes more and more marked as time goes on. At birth the terminal part of the cæcum, or the appendix as it is called, forms a tapering prolongation of the cæcal diverticulum.[2] It is not until later that a definite line of

[2] Keith, "Human Development and Morphology."

demarcation is to be seen between the two structures. The fetal type of cæcum is, therefore, an inverted cone whose apex imperceptibly shades off into a prolongation of the appendix. It will now be seen that the appendix represents the terminal portion of the original cæcum.

Turning to the animal series for suggestions to aid in the explanation of this phenomenon, it is found that a distinct appendix is only seen in man, anthropoid apes, lemurs, and the opossum. On the other hand, it is common to find a lymphoid structure at the distal portion of the cæcum, which undoubtedly represents the appendix.[3] In the latter series of examples, the cæcum and its lymphoid appendage conform to the human fetal type. It is quite a later phase both in ontogeny and phyllogeny that the cæcum loses its conical form by the development of pouches between its three thin muscular bands. And it is by that that the appendix becomes distinctly separated.

As age advances the appendix undergoes changes both in position and structure. In the fœtus it is situated along with the cæcum under the liver, and later it descends into the iliac fossa. Sometimes it remains in its fetal position, or it may be arrested at any part of its descent. An examination of the appendices for different decades shows that they are both relatively and absolutely longest and thickest between the ages of ten and thirty. The walls during this same period are stuffed with lymphoid nodules. After the latter age the appendix begins to undergo a slow involution both in length and thickness. The lymphoid nodules disappear also, though more slowly and uncertainly.

Robert Morris[4] has directed attention to the association of pain, intestinal, and general symptoms with this involution. The change is certainly of a chronic inflammatory character such as would be expected to occur in nearly every one who has an appendix, and is the result of the continued irritative

[4] Morris, Am. Journ. of Obstetrics and Gynæcology, 1901, 439.

[3] Berry, Journal of Anat. and Phys., 1910.

action of bacteria throughout years. Still more recently the occurrence of appendix-dyspepsia (its more modern name) has been rediscovered.

PATHOLOGY OF CHRONIC TYPHLITIS AND APPENDICITIS.

It is a matter of more or less common knowledge that, as years pass, changes are found in the appendices of people who have never had a clinically recognizable attack of appendicitis. How much of these changes are physiological it is impossible to decide; and in this connection it is not so important, because, whatever they are, they will interfere with the normal performance of the work of the appendix, and so lead to evil results. One of the best known of the changes is the disappearance of the lymphoid follicles that are so plentiful in early life. Is this disappearance pathological or physiological? Yet if sections are cut of appendices removed from people over sixty, or even older, these follicles sometimes can be found in abundance. The persistence in these cases may be due to individual variations in the rate of aging; or perhaps more probably, they indicate that the disappearance is of more pathological than physiological import.

In considering the physiology of the appendix, it has been shown that the cæcum is the first great place of rest or stasis for the products of digestion after they have left the stomach, consequently the appendix is a tube which serves as an index to the chemical and bacteriological processes which occurred there. One well-known property of lymphoid tissue is that its constituents are actively protective to the organism against foreign invaders. Situated in a blind tube in whose lumen are represented types of the organisms of the large bowel and their fermentations, the lymphoid follicles must have a great deal of work to do, more even than the tonsils, to which the appendix has been compared. It is well known that the tonsils undergo fibrosis or chronic inflammation without the occurrence of an acute attack. In a like manner do similar changes occur in the appendix, but unfortunately there is a very marked difference. Fibrosis of the appendix interferes with

the efficiency of its peristaltic action, and the tube becomes incapable of emptying itself. By these means a vicious circle is established, as the more material (pabulum) which remains the more will bacteria flourish, and the more likely is it that the chronic inflammation will progress, and the organ become still more incapable of performing its own evacuation. Such a condition may be aptly called appendicular constipation. The inspissation of the contents will lead to the formation of an appendicular calculus of fecal concretion, which may be likened to scybala elsewhere in the large intestine. It may be assumed that the presence of concretions indicates the existence of pathological change. And their association with chronic inflammation explains the fact that they are frequently found by the surgeon and the pathologist in cases which have never had a clinically recognized attack of appendicitis.

The result of chronic appendicitis may be at times far more extensive than this. The fibrosis with its subsequent contraction leads to further disappearance of the lymphoid follicles and impairment of the muscular action. The appendix consequently becomes an inert breeding ground for microorganisms, and if they escape into the cæcum the multiplication is continued there. The cæcum will be affected sooner or later by the continued escape into it of toxic material elaborated in the appendix, and, as it is necessary that the products of digestion remain there until they are of suitable consistency to be passed on into the ascending colon, those toxic materials will become still further elaborated and give rise to chronic typhlitis. Again there is the vicious circle, as the inflammatory condition will impair the contractile power of the cæcum, and so lead to further bacterial growth and further chronic inflammation. In this way a colitis may be established throughout the entire length of the large bowel.

A SIMPLE METHOD OF SUTURING ALL HOLLOW VISCERA.

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A GRADUAL process of simplification during years of intestinal and stomach work finally brought me to the routine use of a method which study of the literature shows to represent in a measure the apex of a pyramid to which others have contributed the underlying strata. In reviewing the propositions which are of importance here, it is not logical, in view of what follows, that I take up the immense number of suggestions which have been made for uniting hollow viscera by methods other than those which deal with a single row of sutures embracing all coats.

The history of the continuous suture in gut work runs back much farther than many perhaps imagine. As early as 1724 Heister [1] wrote regarding it as follows:

> Wenn aber die Wunde im Darm gross ist, so ist dieselbe meinstens todtlich. Denoch weil man auch solche Patienten ohne Hülfe nicht lassen soll, so muss man dergleichen verwundte Darm ohne die Nath nicht in den Leib bringen, sondern dieselbe vorher zunahen: welches bishere durch die, so gennante Kurschners' Nath verrichtet worden, welche (Tab. viii, Fig. 10) angemahlet, reprasentiret wird. Zu dieser werden erfordet eine gemeine gerade dunne Nadelgleichen gewachster seidender oder leinener Faden.

It is not stated definitely by him whether or not he advocated perforating sutures; however, the well-known glovers' stitch of which he writes surely takes in the entire thickness of the leather, hence it is probable that Heister advocated a continuous suture which penetrated all the coats of the bowel. He quotes the work of earlier authors, which goes to show that this sort of manœuvre was known long before his time. Of course none of these very early authors appreciated the fact that serous coats must be approximated, hence their work can be

regarded as of historic interest only. Still it must be admitted that such accidental approximation was probably secured in many instances because some of their patients recovered.

In 1826 Jobert [2] used a perforating interrupted suture.

In the same year, according to Jeannel,[3] Breidenbach used a suture which was apparently somewhat similar to that of Jobert, although there seems to exist a degree of uncertainty as to just where this method was published and whether or not interrupted stitches were of the variety which embraced all the coats of the bowel.

Gely [4] was the next, in 1842, to use in a long series of animal experiments a perforating suture, which, however, was of the continuous variety.

Three years later Moreau [5] advocated an interrupted perforating method in which a cuff of the mucosa was stripped out of one end of bowel into which the other was invaginated.

Vezien,[6] in 1871, wrote of using interrupted perforating stitches very similar to those of Jobert.[7]

In 1882 Nussbaum [8] advised that all intestinal sutures embracing all the coats of the bowel be of the interrupted variety and have the knot on the inside.

In 1885 Bishop [9] used perforating gut stitches. M. E. Connell,[10] in 1892, renewed the interest of the surgical world in this form of suture by publishing an oblique one-row method with a continuous suture embracing all the coats. In the same year Maunsell [11] published his unique proposition of slitting the bowel laterally, drawing the ends to be united through this slit, and sewing them together with a single interrupted row embracing all the coats. The next step was registered by Cushing,[12] in 1899, when he proposed a continuous single row which was not intended to embrace anything below the submucosa.

Popular recognition of the single row suture embracing all the coats was not, however, apparent until 1903 when F. G. Connell [13] gave to the world his method of interrupted suture. In the same year Horsley [14] published what he calls a single row over-hand continuous suture embracing all the coats. Wiggin [15] demonstrated a single row interrupted stitch

with all knots inside. In 1905 Horsley[16] again wrote concerning viscera of unequal size.

The method herein advocated consists of a single row of continuous silk sutures taking in all of the viscera. No internal support is used. No special forceps or other instruments are necessary; all that is required is simple straight cambric needles and silk or other thread, as may be desired. I prefer silk, on account of its well-known physical properties, to any other suture material and use it in this way: two very fine strands of double length are carried through the eye of a Number 7 needle, then the resulting four are twisted together so that the needle remains at the end of a completed cable from which it cannot become detached. This is waxed, sterilized, and a large number held in readiness for immediate use. Four strands are used because two are not enough to make a smooth cable.

The experience of many operators has proven the single row suture anastomosis to be perfectly safe. Two or even three rows can then not guarantee more, since the rules of logic preclude the use of a comparative or superlative term that can amplify "perfectly safe." I will add that in careless or inexperienced hands more than one row might add somewhat to the safety of the operation, but this proposal is not for the beginner.

In comparing continuous and interrupted suture, all must admit that the continuous can be applied more quickly. A second advantage possessed by it is that it alone tends to hold the opposed viscera more tightly together when the tension within the lumen increases, as is likely after postoperative gas formation takes place.

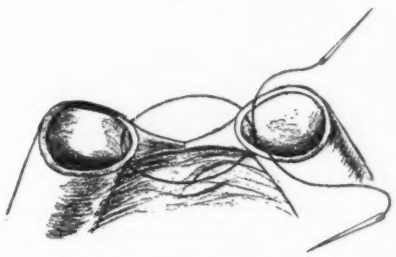
Now as to the value of perforating suture. In one sense a stitch which takes in all the coats is best because it is sure to embrace the submucosa, which is the only one that offers a sure foundation. F. G. Connell proved long ago that it is practically impossible to catch submucosa many times without some of the needle holes entering the lumen of the bowel. This was done in a most ingenious manner by comparing the

thickness of this layer with the diameter of the needle ordinarily used. Since it has been abundantly proven by this author as well as by others that perforating stitches are harmful in theory only, why not carry all gut needles into the lumen and thus be sure to get the firmest sort of a hold?

END-TO-END ANASTOMOSIS.

Two threads about fourteen inches in length with a needle on each are tied together at the free ends; thus we have resulting a strand slightly over two feet in length with a needle on both ends. By referring to Fig. 1, it will be noted that the first step in the operation begins within the lumen of the gut on the left, each needle being carried out of the viscus in

FIG. 1.



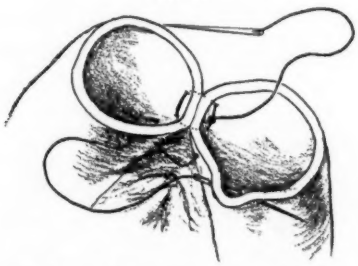
End-to-end anastomosis, first stage.

such a manner as to embrace the mesenteric insertion, the same being done to the mesentery of the bowel to the right as the two needles enter the lumen. These two threads are now tied together after the knot has been drawn tight and the resulting condition appears in Fig. 2. This is a most important step, since, as shown by F. G. Connell and others, it guarantees in a measure the blood supply to the part on which we are working.

Fig. 2 illustrates the next step in the procedure. A few stitches of the continuous Connell variety are taken, all of the coats being pierced and a close approximation being secured as the thread is drawn tight. As illustrated by the needle next the reader, most of these sutures are put in by making the in-and-out excursions in one and the same motion

in very much the same way that a Lembert suture is applied, the sole difference being that here all of the coats are embraced. This needle is employed for a distance of about one-third the way around the opening, when it is dropped and exactly the same manœuvre repeated in the opposite direction with the needle farthest from the reader, the single difference being that this latter needle is employed for the remaining two-thirds of the circumference or until it meets the one first used, when it will be found that the opening has been completely closed so quickly and simply as to astonish the operator. Almost all of the stitches will have been put in from the outside, and nowhere will anything but the peritoneal coat show. If the

FIG. 2.



End-to-end anastomosis. second stage.

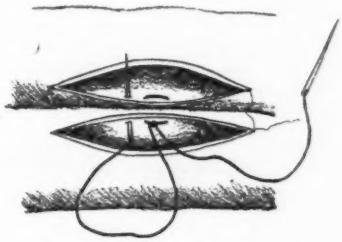
tension of the thread has been right it will be impossible to see any portion of it except the knot, which, contrary to theory, has done no harm if left exposed, although I must say that I have usually placed one Lembert suture over it for cosmetic reasons. Beginning the anastomosis at the mesentery and working away from it in both directions as described above, renders the manipulation of this important and dangerous territory much safer and easier than is the case when an ordinary continued suture which has gone clear around the gut is finished at the mesenteric insertion.

LATERAL ANASTOMOSIS.

Fig. 3 shows two loops of intestine placed side by side, with the first suture tied within one lumen, leaving the two needles ready for use. The one on the left is employed to

make an ordinary running Connell suture to the left of the first knot. This is continued only until the corner is turned, when this needle is dropped and the same manœuvre carried out with its mate to the right of the first knot. The advantage of beginning in the middle to make this suture is that both the difficult corners can be turned with the whole wound wide open, which is not the case if the operator begins at either end. Now that the posterior row has been completed and drawn tight, the operator has nothing left to do but continue the anterior row, inserting the stitches in the manner shown by the needle next the operator in Fig. 2. Each thread makes half of this anterior row, the two meeting at the middle of the wound, where they are tied as shown in Fig. 4, and a simple

FIG. 3.



Lateral anastomosis, first stage.

anastomosis thus concluded. Again a Lembert suture may be superimposed if desired, although I must state that I have frequently forgotten it and the results have been just the same as where it was used.

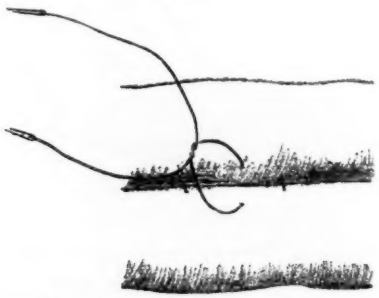
END-TO-SIDE ANASTOMOSIS.

This somewhat less common form of operation is depicted in Fig. 5, where a Roux gastro-enterostomy is in contemplation. Again we have emphasized the importance of the first silk loop which approximates the middle of the stomach wound with that portion of the small intestine which embraces the mesenteric insertion. It is scarcely necessary to dwell upon the further steps of the operation, since they are merely a combination of those given in end-to-end and lateral anas-

tomoses. The posterior row approximates the two viscera, being inserted after the continuous Connell method, while the anterior row is again made after the manner of using the needle next the reader in Fig. 2. The resulting ends of thread are tied as in Fig. 4, and the operation is complete.

This form of suture has been found equally well applicable wherever tried and, as the following list will show, its use has met the widest possible indications in end-to-end, lateral, and end-to-side anastomoses. The stomach has been connected with the small bowel anteriorly as well as posteriorly by the lateral method as well as end-to-side in the Roux operation. Small bowel has been connected with small bowel by both the lateral and end-to-end methods. The small bowel has been

FIG. 4.



Lateral anastomosis, second stage.

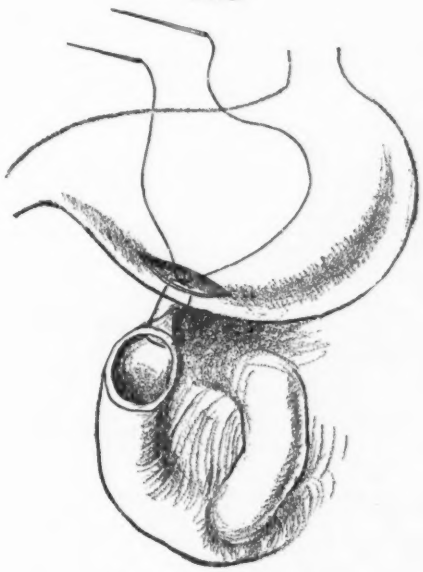
united with the large bowel, not only laterally but end-to-end. The gall-bladder has been anastomosed into the stomach in one instance and in another into the large bowel. Not only has this method been used in seemingly normal viscera but on those changed by disease in almost every conceivable manner. It has proven its value in a distended gut above an acute obstruction, also in the œdematous condition associated with acute peritonitis. It has been equally successful in the compensatory thickening associated with chronic obstruction.

After resection of the head of the ascending colon, there has been practically no difficulty in making end-to-end anastomosis between the ileum and colon of vastly different diameters. To illustrate the ease and speed with which the method

can be applied, it is enough to state that a double resection with double anastomosis has been accomplished in about the same time that the single operation of this sort formerly took where complicated methods of bowel union were used. The Roux gastro-enterostomy has been frequently used in my work recently, since this simplified suture has made it possible to perform the operation in about the same time that was formerly required for a posterior gastro-enterostomy alone.

I have used this method for more than two years in every

FIG. 5.



End-to-side anastomosis.

operation which I have done upon the hollow viscera of the abdomen, a very large number of cases in all.

That it is a thoroughly useful procedure, to say the least, is attested by the fact that only two of all of these patients died in the hospital of any cause, neither of them with peritoneal symptoms; one expired sixteen days after a gastrectomy and the other two days after an anastomosis between gall-bladder and stomach for the relief of biliary obstruction in cancer of the pancreas.

This method is safe, because all of the coats of a viscus are embraced and consequently every stitch has a firm foundation.

No form of suture operation could be done more quickly, because the smallest possible number of stitches and knots are employed.

No permanent ill after effects are to be anticipated, since a very scanty diaphragm is formed.

The requirements of modern surgical technic are not satisfied by any method of anastomosing hollow viscera which does not guarantee safety, rapidity, and absence of bad after-effects.

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THE RECTOSIGMOIDAL ARTERIAL ANASTOMOSIS.

ITS IMPORTANCE IN THE TREATMENT OF CARCINOMA HIGH IN THE RECTUM.

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It has occasionally been noted that operations by the sacral route upon carcinomas situated high in the rectum have been followed by gangrene of the bowel which has been freed to permit of the establishment of a perineal or a sacral anus. On reading the mortality rate in this field of surgery and having observed some of the unfortunate results, one is struck by the repeated report of partial or complete gangrene of the bowel in the fatal cases. It was with this point in view that this work was undertaken, with the hope that some definite idea could be obtained of a method to avoid this complication.

Quenu and Hartman were the first to open the abdomen to ligate directly the superior hemorrhoidal artery to check hemorrhage and to permit of an easier mobilization of the rectum. Hartman more recently has shown that the safe point for ligation of its superior hemorrhoidal artery is proximal to its junction with the anastomotic loop from the sigmoidal artery (Figure 1, *A*). After ligation at this point the blood passes from the sigmoidal artery through the anastomotic loop and into the rectal vascular system below the level of the ligature. Ligation of the superior hemorrhoidal artery distal to the anastomotic loop would result in gangrene of the stump, as the main vessel distal to the loop would be occluded, and the blood supply to the rectal wall cut off.

It has been demonstrated experimentally by Rubesch that the area supplied by the inferior mesenteric artery can be in-

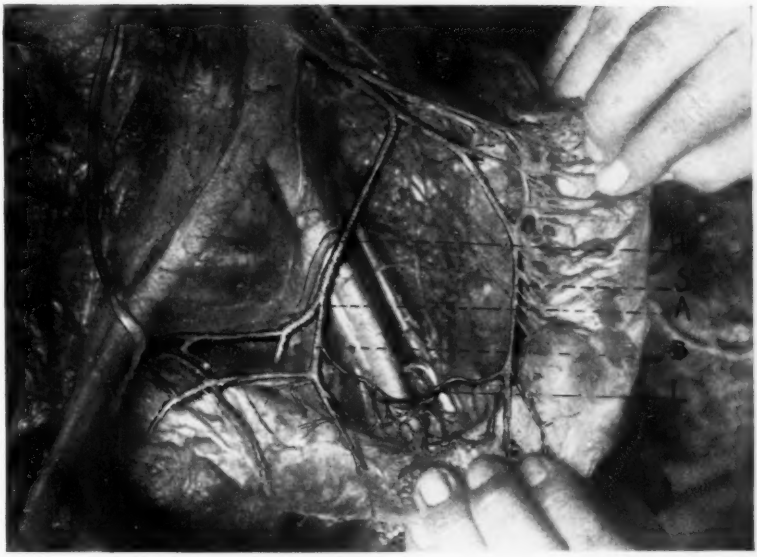
The author wishes to express his appreciation of the kindness of Drs. Bensley and Harvey for their assistance and for the use of their dissecting room material.

jected through the superior mesenteric artery after ligation of the former. This observation can only be regarded as an interesting anatomical fact, for clinically a collateral circulation is not provided rapidly enough after ligation of the inferior mesenteric artery to prevent gangrene, even if the branches of the artery are not to be regarded as terminal arteries. Sudeck was the first to emphasize the necessity of an abdominal incision to determine the exact location of this anastomosis, which he names the "critical point."

Variations in the rectosigmoidal anastomosis are common. With the view of determining the frequency and nature of these variations, and the relation of the vessels entering the anastomosis to the bowel wall and to each other, I have examined 21 subjects. The vessels had been injected with a starch mass containing lead oxide. In some cases the vessels were dissected out to the bowel wall, while in others the relationship of the vascular loop was determined by X-ray pictures. Reproductions of some of these accompany the text.

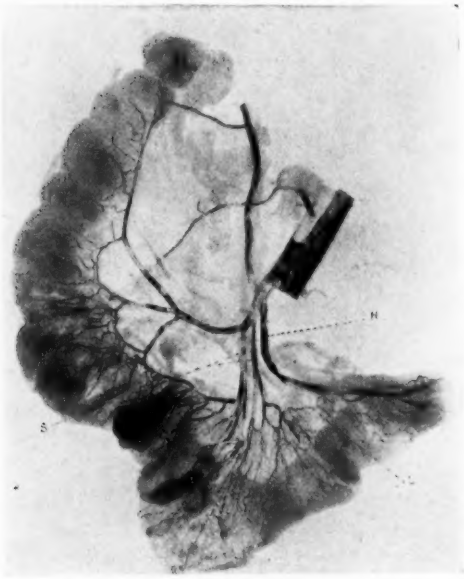
Three of the subjects were females. These showed no variations which can be considered peculiar to the sex. A definite, well-developed loop was absent in two cases (Fig. 2). In these instances ligation of the superior hemorrhoidal artery at any point would have resulted in gangrene, as the vascular anastomosis within the wall of the bowel would not furnish enough blood. After resection of the rectum for a high lying carcinoma in such cases, it would be safest to draw the proximal end of the rectum or sigmoid out through the abdominal wall and form an iliac anus. The loop varied in calibre from an artery as large as the vessels it connected to a mere thread-like vessel in one instance. The loop was found on an average 1.5 cm. below the level of the promontory of the sacrum (Fig. 1). In one subject, however, the loop was found 5 cm. below the promontory. The anastomosis was found at a varying distance from the bowel. The rule of clamping the vessels as far back from the rectum as possible, to avoid injury to the blood supply when operating by the sacral route, results in missing the loop where it lies close to the bowel, as in Figs.

FIG. 1.



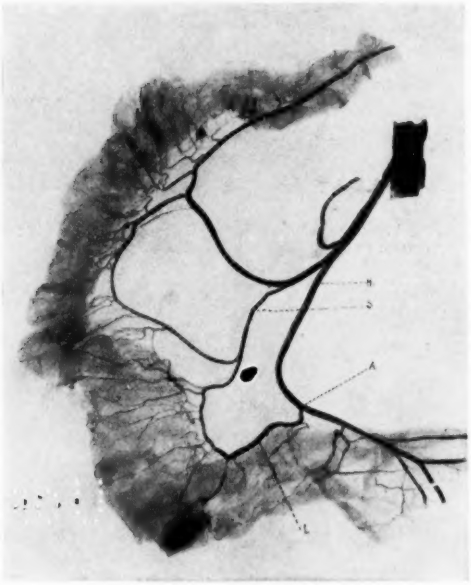
A, critical point; *B*, too low to supply entire rectal system; *S*, sigmoid; *H*, sup. hem. artery; *L*, loop anastomosing with sup. hem. artery below bifurcation.

FIG. 2.



S, sigmoidal arteries; *H*, sup. hem. artery; *L*, no well-developed loop present.

FIG. 3.



A, critical point; *S*, sigmoidal artery; *H*, sup. hem. artery; *L*, loop lies close to bowel.

FIG. 4.

A, critical point; *S*, sigmoidal artery; *H*, sup. hem. artery; *L*, loop close to bowel.

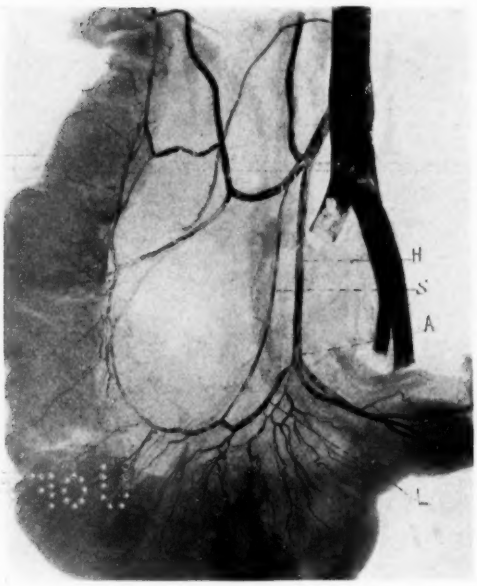
FIG. 5.

A, critical point; *S*, sigmoidal arteries; *H*, sup. hem. artery; *L*, loop close to bowel.

FIG. 6.

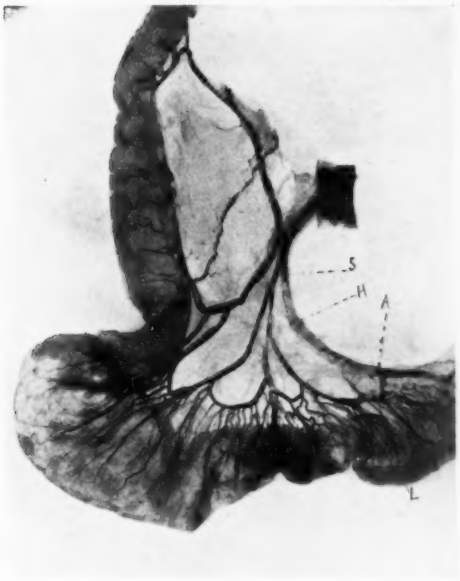
A, critical point; *S*, sigmoidal vessels; *H*, sup. hem. arteries, bifurcation proximal to anastomosis; *L*, loops double, distant from bowel.

FIG. 7.



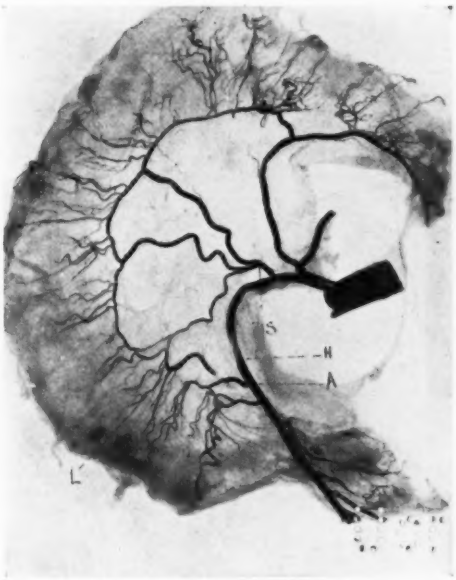
A, critical point; *S*, sigmoidal artery; *H*, sup. hem. artery; *L*, loop.

FIG. 8.



A, critical point; *S*, sigmoidal artery; *H*, sup. hem. arteries; *L*, double loop.

FIG. 9.



A, critical point; *S*, sigmoidal artery; *H*, sup. hem. artery; *L*, loop.

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3, 4, and 5. With relations as shown in Fig. 6, on the other hand, there would be great danger of catching some portion of the loop, because it arises so far from the bowel. After occlusion of the vessels, gangrene of the stump occurs in greater or less extent, the fæces escape into the wound, and if infection reaches the peritoneal cavity the patient dies of peritonitis.

In several instances the bifurcation of the superior hemorrhoidal artery occurred before the sigmoidal loop joined the rectal supply (Figs. 1 and 5). In most of these cases the sigmoidal branch joined with the upper division of the hemorrhoidal artery; in two cases, however, it anastomosed with the lower division. In these instances ligation immediately above the junction of the sigmoidal loop (Fig. 1, *B*) would be dangerous, and ligation should be performed above the point of division of the superior hemorrhoidal artery at *A* in Fig. 1. This division of the superior hemorrhoidal artery is variable as shown in Figs. 4 and 5, the length of the main artery varying from 2 cm. in Figs. 1 and 5 to 6 cm. in Fig. 7. In some instances this artery passes down as a single trunk from the inferior mesenteric artery to its subdivision upon the rectum (Figs. 4, 8, and 9).

Section of the superior hemorrhoidal artery above would permit of mobilization of a considerable length of the sigmoid (Figs. 1, 3, and 9). With a condition as shown in Fig. 7, section of the hemorrhoidal artery and the small division of the sigmoidal artery would give ample movement to the sigmoid colon; but with a vascular system as pictured in Figs. 2, 4, 6, 7, and 8, several large trunks would have to be sacrificed to obtain any marked descent of the sigmoid.

CONCLUSIONS.

Total twenty-one subjects: loop present in 19 cases; superior hemorrhoidal artery bifurcated before junction with loop, 7 cases; loop anastomosed with lower division, 2 cases.

Lowest loop was found in one subject with the critical point almost in bottom of cul-de-sac of Douglas. Vast majority of other cases were found about 1.5 cm. beneath the promontory of the sacrum.

Sixteen subjects showed the loop close to the bowel.

Five subjects showed the anastomosis formed by large loops at a distance from the bowel.

1. Following high resection of the rectum, gangrene of the stump can be avoided by ligation of the superior hemorrhoidal artery proximal to the point of entrance of the anastomotic loop from the sigmoidal artery.

2. Where high resection of the rectum is to be done by the sacral route, a preliminary abdominal incision is of value to determine the presence and location of the critical point, the relations of the superior hemorrhoidal artery, and permits of a definite placing of ligatures to check hemorrhage.

3. The anastomotic loop is not present in some cases. High resection of the rectum for carcinoma in these cases should be terminated with a permanent colostomy.

The X-ray pictures are printed as viewed from behind.

REFERENCES.

Quenu and Hartman, Chirurgie du rectum, Tome 2, p. 199.
Hartman, ANNALS OF SURGERY, 1909, l, 1091.
Rubesch, Beiträge klin. Chir., Bd. lxvii, 1910, 480.
Sudeck, Münch. med. Woch., 1907, 1314.

THE BONE METASTASES OF HYPERNEPHROMA.

A COMPLETED RECORD OF A CASE WITH SOLITARY BONE METASTASIS.

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IN the ANNALS OF SURGERY for December, 1906, p. 851, I published the report of certain cases of hypernephroma occurring at the Massachusetts General Hospital clinic. One of these cases was reported in considerable detail. I wish here to complete the report of this case, numbered XI in the former paper.

The facts of interest in connection with this particular case are as follows: It was thought previous to operation that this man had a sarcoma of the upper end of the shaft of the right humerus (Fig. 1). An amputation at the shoulder-joint was done (Fig. 2). The microscopic examination of the removed tumor demonstrated that it was a hypernephroma (Figs. 3 and 4). Before the patient recovered from the anæsthetic, careful palpation of both kidneys discovered a slight enlargement of the left kidney. He had had no pain in the side and no hæmaturia. During the casual inspection in the routine ward examination this slight enlargement of the left kidney was not detected previous to operation.

Certain questions of practical importance arose at that time, namely: What is the proper attitude toward the kidney tumor as yet manifesting no symptoms? Shall it be removed? If removed what will be the prognosis? In this particular case the diagnosis of hypernephroma was made first from an examination of a metastasis. The metastasis first suggested the presence of a hypernephroma. The very great proneness of the hypernephromata to metastasize as demonstrated by autopsy reports and the fact that the metastases are usually multiple would lead one to give an unfavorable prognosis in this particular case,

even after nephrectomy, were it not for a series of very careful observations by Albrecht[1] from Hochenegg's clinic in Vienna, to the effect that there may exist a solitary hypernephroma metastasis in bone. In this Case XI of my series, it was thought possible that this bone metastasis, which had been removed by amputation, might be the only metastasis in the body.

The feeling with regard to this case at the time of the operation was that a chance for the man's life lay in a nephrectomy, but that this would be efficacious only if there were no other metastases in the body. Nephrectomy was urged upon this man but he constantly refused operation.

In January, 1910, a little less than five years after operation, he died, wasting away as if with some blood disease. It was possible to make a complete autopsy with the exception of an examination of the spinal cord. The cranial cavity, thorax, and abdomen were thoroughly examined. There had been no return of the trouble locally at the seat of the original operation. The left kidney was as large as two adult fists. The accompanying photograph (Fig. 5) shows the relation of the tumor to the kidney itself. The pathological report upon the tumor made by Dr. Oscar Richardson is appended. No metastases were found in any part of the body. The man had had no symptoms, so far as is known, from the kidney tumor.

This case, then, first reported in the ANNALS OF SURGERY for 1906, is now rendered complete by autopsy. This case adds one more bit of evidence to the two cases from Hochenegg's clinic illustrating the fact that one bone metastasis may be the sole metastasis present in the body. Had a nephrectomy been done soon after the operation for removal of the upper extremity containing the metastatic focus, the man's life would have been prolonged.

Report of microscopical examination of hardened and stained sections from a tumor of the kidney, Case XI, Series Massachusetts General Hospital Hypernephromata, April 7, 1910:

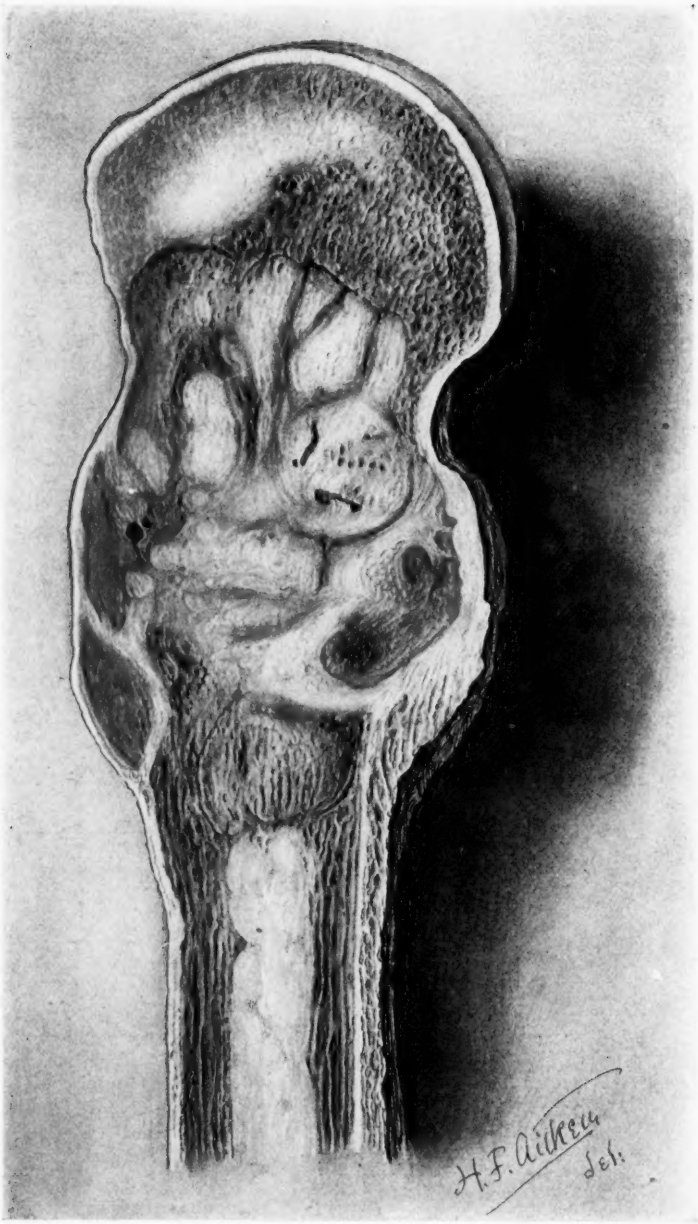
The sections all show a distinct meshwork of capillaries between and along which rest irregular columns and small masses of rather large epithelial-like cells with a rather well-marked eosin staining granular protoplasm in places, but showing elsewhere rather generally a thin vacuolated, faintly staining protoplasm. The nuclei are rather large,

[1] Arch. f. klin. Chir., 1905, lxxvii, 1073.

FIG. 1.

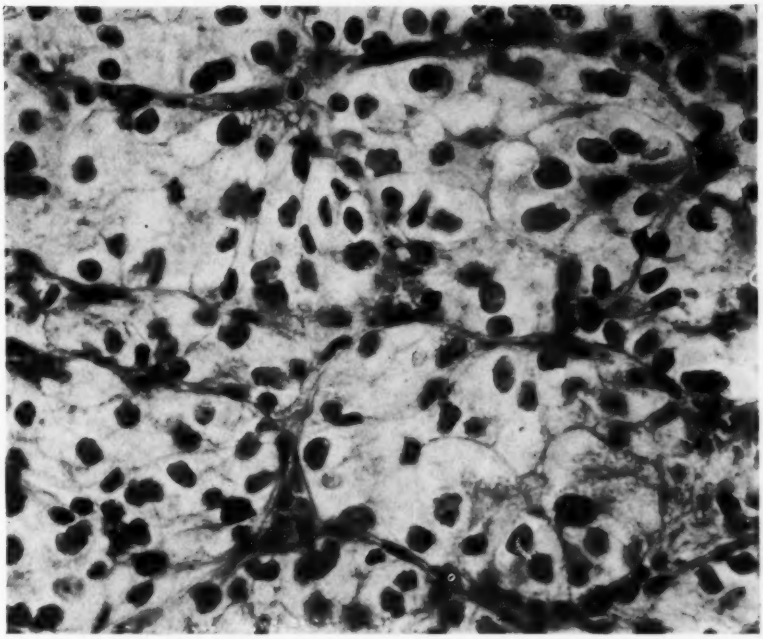
X-ray of upper end ot humerus, showing region of tumor, *D*, *C*. *A*, clavicle ; *B*, acromion ; *C*, shaft of humerus ; *D*, head of humerus.

FIG. 2.



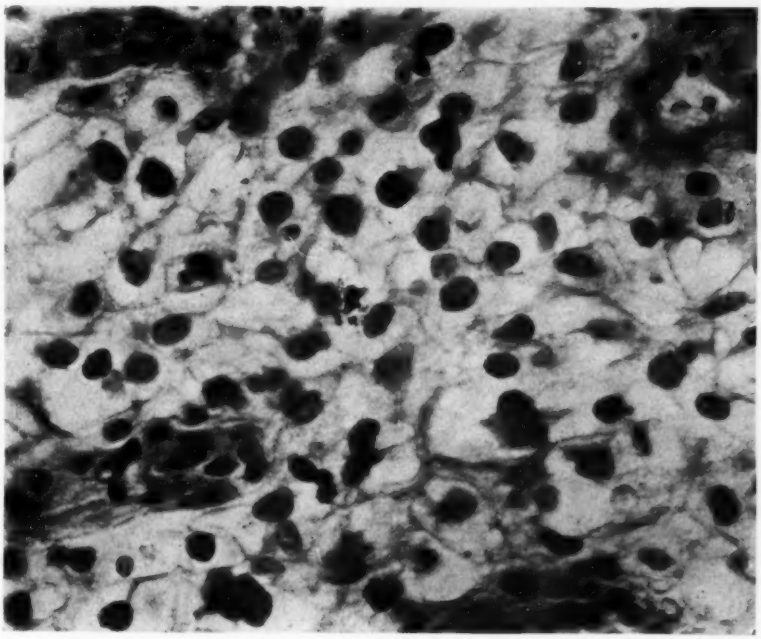
Hypernephroma, metastatic, in upper end of the shaft of the right humerus. Drawing made from a section of the gross specimen.

FIG. 3.



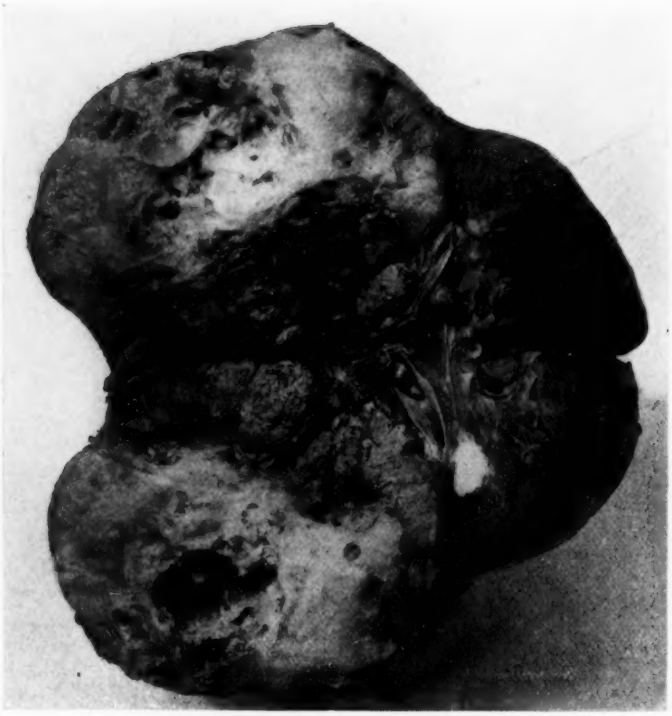
Microphotograph of a section from metastatic hypernephroma in upper end of humerus. Oval polygonal cells—preservation of rim of cytoplasm, deeply staining nucleus, perinuclear lightly staining spaces. Microphotograph by Mr. Brown, M. G. H. Laboratory.

FIG. 4.



Microphotograph of a section from metastatic hypernephroma in upper end of humerus. Higher power than in previous plate, Fig. 3.

FIG. 5.



Hypernephroma of kidney of Case XI removed at autopsy. The kidney and tumor have been split. Each half of the section is shown in the photograph. The photograph was by Mr. Brown of the Pathological Laboratory of the Massachusetts General Hospital. See pathological report.

well defined, and show well-marked chromatin granules. In instances nucleolus-like masses are seen. The protoplasm of the cells which are arranged along the walls of the capillaries rests in close association with the wall of the capillaries. This arrangement of cells and capillaries resembles quite a little the structure of the cortex of the adrenal gland. In many places there are coarse trabeculæ of connective tissue from which finer prolongations extend in among the capillary network. Here and there in the midst of the connective tissue there are collections of small round cells. The peripheral cells of some of the small masses of tumor cells are arranged around and along the walls of the capillaries in such a fashion that roughly they present a tubular formation. In many places the tumor sections show well-marked areas of necrosis. At other points the capillary walls surround large oval spaces with comparatively few atrophic degenerated looking cells resting along the walls of the capillary meshwork.

Diagnosis: Hypernephroma.

(Signed) O. RICHARDSON, *Assistant Pathologist, Mass. General Hospital.*

PLASTIC REPAIR OF THE THUMB.

BY H. A. HAUBOLD, M.D.,

OF NEW YORK,

Clinical Professor in Surgery in the New York University and Bellevue Hospital Medical College; Visiting Surgeon to the Harlem and the New York Red Cross Hospitals.

THE case embodied in this report possesses interest because of the fact that the patient came under the observation of the writer after the decision to amputate the afflicted thumb had been reached, and because the measures employed eventually made preservation of a useful member possible. It is also regarded as worthy of record on the ground that the thumb is, as is well known, "half a hand," and its removal entails considerable loss of function and consequent lessening of the earning capacity of one concerned in doing manual labor for a livelihood.

Miss X., aged fifteen, came under observation December 4, 1909. The history obtained at that time was that three months previously she had broken off a cambric needle in the left thumb near the interphalangeal joint. This was removed under local anæsthesia. Several days later the thumb became painful and swollen, and evidently was quite acutely infected. This was treated with a wet carbolic acid dressing which resulted in a carbolic acid gangrene.

The consequent sloughs separated very slowly, and at the end of three months the thumb appeared as shown in Fig. 1. The distal phalanx is contracted, the interphalangeal joint is ankylosed, and the area of granulation shown had not undergone any change in size for several weeks. It was believed that the infection had invaded the joint and exfoliation of bone had taken place. A radiograph (Fig. 2) showed this to be true. It will be seen that the joint surfaces are quite effaced and that some of the phalanges themselves have separated. The extent of bone disease is best recognized by comparing the radiograph

of the afflicted thumb with that of the other normal thumb contiguous to it.

It was deemed proper to make an effort to save the thumb, and it was believed that an ankylosed interphalangeal joint was less objectionable than would obtain were an amputation at the metacarpal phalangeal articulation performed. The indication seemed to be to excise the granulating area of soft tissues, remove what dead bone was still existing, and make plastic repair of the denuded area.

Accordingly, on December 6, 1909, the technic was carried out in the following way: The entire granulating surface, together with the contiguous scar tissue, was excised. Only a very small sequestrum was found, and this was removed with the Volkmann spoon. The joint cavity itself was filled with new bone which was only slightly disturbed in removing the sequestrum. A bridge flap was now fashioned at the anterolateral aspect of the thigh. Its conformation and application to the denuded area on the thumb are quite well shown in Fig. 3. This site was selected for the purpose after considerable experimentation with the thumbs of the writer and his assistants. The reader is asked to place his own thumb in position to allow of its dorsal aspect being placed in the relationship shown in the picture (Fig. 3) on a portion of the body without twisting the wrist-joint and thus making tension on the flap. It will be found that the one selected in the case reported is perhaps the only one available for the purpose, except perhaps the pectoral region on the side of the body opposite to the thumb used. The latter site would not be objectionable in the male, however in females it is fair to assume that this region is regarded as offering certain allure to the opposite sex which the scarring following an operation of this sort would be likely to destroy.

The bridge flap consisted of skin only. The subcutaneous fat was left attached to the fascia lata, making a bed for the palmar surface of the thumb to rest upon.

The edge of the flap toward the wrist was fastened in place with three interrupted silkworm gut sutures introduced with a small Hagedorn needle. The distal edge of the flap was attached by a single silkworm gut suture. The latter step was precautionary, as no doubt the introduction of several sutures in this situation would have traumatized unwarrantably the already badly nourished distal portion of the part.

December 10 (four days after the operation), one-half of the lower portion of the flap was sectioned with scissors. The edge of the wound on the thumb side bled quite freely, showing that the circulation was maintained at this time.

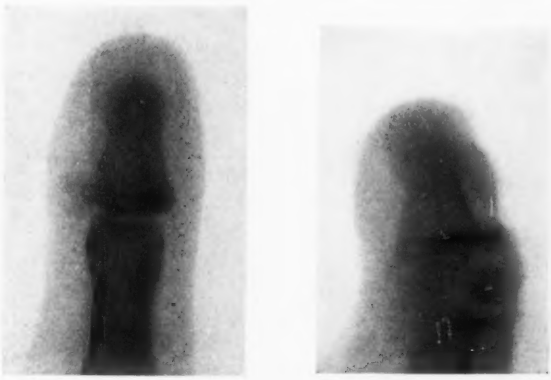
At this time the edge of the wound in contact with the thumb showed a slight reactionary inflammation. There was no evidence of infection, however, and the patient's general condition was very satisfactory. The entire arm, hand, and thigh had been immobilized at the time of the operation, using adhesive plaster straps for the purpose. Of course considerable annoyance was caused the patient by the strained position she occupied, and especially was it difficult to take care of the urine and fæces without disturbing the parts concerned in the repair. The latter consideration would not be so important a factor had it been feasible to use a portion of the trunk for the purpose, as then immobilization of the parts would have been much simplified. Due consideration should be shown this aspect of the situation in cases where plastic repair is attempted; however in this case it would seem that the method employed was justified.

December 12 (six days after the primary operation and two days after partial section of the lower portion of the flap), the upper portion was sectioned to the extent of one-half its breadth. The second section was made at the side of the bridge flap opposite to the one made two days before, in the lower portion of the flap. This was done in this manner to conserve circulation from the widest possible contiguous areas. At this time there was some odor emanating from the wound; however this was found to be due to secretion and not, as was at first feared, to sloughing. When the upper section was made, bleeding occurred from both the thumb and the thigh sides of the incision, showing that circulation was quite maintained in the flap. The distal end of the thumb was quite buried in granulating tissue, which had grown up from the thigh wound as will be seen in Fig. 4. There was but a meagre portion of the thumb protruding from that side of the flap at the operation (Fig. 3), and its burial in granulation tissue is not to be wondered at. Fig. 4 shows the condition of affairs at this dressing. The lower wound where the flap was first partially sectioned had begun to granulate at this time. The upper section shows more plainly, being freshly made a few minutes before the

FIG. 1.

Appearance of thumb three months after carbolic acid gangrene.

FIG. 2.



Sound thumb. Affected thumb.

Radiographs of afflicted thumb and sound thumb.

FIG. 3.

Bridge flap on anterolateral aspect of thigh. Thumb fastened to flap with silkworm gut sutures.

FIG. 4.

One-half of either margin of bridge flap sectioned. The section to the left already beginning to granulate. Upper (right) section freshly made. Distal end of thumb buried in granulation tissue.

FIG. 5.

Appearance of thumb immediately following complete dissociation from thigh. Streak of blood from edges of flap showing that nutrition is maintained.

FIG. 6.

Lateral view of thumb nine days after release from thigh Note contraction and adaptation of graft.

FIG. 7.

Lateral view of thumb two months after operation showing farther contraction of graft.

FIG. 8.

Same as Fig. 7 (two months after operation). Dorsal view.

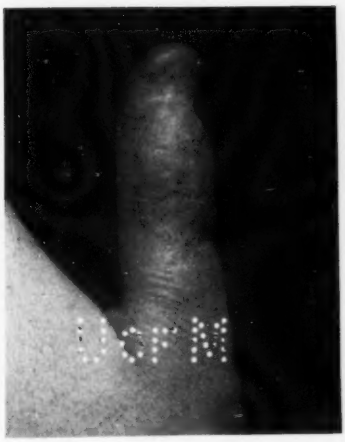
FIG. 9

Elliptical portion of dome of graft excised. Interrupted silk-worm gut sutures inserted.

FIG. 10.

Sutures shown in Fig. 9 tied

FIG. 11.



Ultimate result (about five months after original operation).

photograph was taken. One of the sutures at the wrist side of the flap was removed at this time. On the whole the conditions were favorable, yet there was an abundant amount of secretion which, as already stated, had some odor. Ordinarily the presence of odor may be regarded as of unfavorable prognostic import in plastic cases, though in this case it proved not to be so.

December 14 (eight days after the operation), the flap was entirely sectioned and the thumb released from the thigh. Fig. 5 shows the condition at this time. The flap is seen to extend to a considerable degree beyond the edges of the thumb itself. However the space beneath it is filled with granulation tissue, and if healing progressed we had a right to expect much contraction at both edges of the flap. The edges of the flap bled freely. Indeed a streak of blood is seen in the illustration (Fig. 5) flowing from the thumb across the dorsal side of the hand. This argued well for a successful outcome.

The thigh wound was dressed in the usual way, but the thumb was enveloped in a wet saline dressing. The presence of odor would suggest the employment of antiseptics; however we felt that the nutrition of the parts was best conserved by the use of the sterile saline solution.

December 23 (17 days after the operation and nine days after release of the thumb from the thigh), the conditions present were those shown in Fig. 6. This is a lateral view of the thumb. In front little of the nail is seen. At the sides repair is slowly going on. At each dressing following release of the thumb from the thigh, a small slough formed at the edges of the flap which was each time cut away. This slough formation was no doubt due to the fact that a small area of flap did not receive sufficient nutrition to maintain it.

At this time the thumb did not present a very symmetrical appearance. The thumb is shown in this rather unfavorable condition to act as a guide in similar cases, where unnecessary disappointment might be felt by the patient at its appearance, since, as is shown later on, marked improvement occurs in the end.

February 6, 1910 (two months after the operation), the thumb appeared as shown in Fig. 7. Comparing this to Fig. 6, it will be seen that a marked contraction of the grafted tissue has

taken place, and this as the outcome of natural adaptation and not due to any treatment. The thumb is, however, not to be regarded as one likely to inspire sculptors to ecstasy.

Fig. 8 shows the thumb from its dorsal aspect, the photograph being taken at the same time as that shown in Fig. 7. This illustration (Fig. 8) shows some fine hair growing on the flap, which is also objectionable from a cosmetic stand-point.

February 23, 1910 (ten weeks after the original operation), the dome of the flap was excised by removing an elliptical portion as shown in Fig. 9. The parts bled freely, showing that new blood-vessels had developed in the grafted tissues. The thickened portion was composed of dense connective tissue which was excised to some extent beyond the edges of the superficial incision, with the view of thinning out the graft. Five horsehair interrupted sutures were introduced and when tied the part appeared as shown in Fig. 10.

Fig. 11 shows the condition of the thumb on May 10, 1910 (about five months after the original operation and about three months after the last operation). The ultimate result is an ankylosed interphalangeal joint, a not particularly offensive looking thumb and one which is useful in the performance of most necessary manipulations of ordinary life.

The report of the case is gone into thus in detail with the view of aiding the reader in formulating a method of repair in similar cases. Last but not least, attention is called to the fact that the original affliction was no doubt greatly contributed to by the use of carbolic acid used over a considerable period of time, a measure of doubtful utility at best and always liable to result in some such condition as obtained in this instance.

WRIGHT'S SOLUTION OF SODIUM CITRATE AND SODIUM CHLORIDE FOR DRAINAGE.*

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ONE of the most rational and efficient therapeutic measures that has been offered in the treatment of localized infection is the solution of sodium citrate and sodium chloride devised by Sir Almroth E. Wright. This solution is composed of sodium chloride 4 per cent. and sodium citrate 1 per cent. in water.

THEORY.

Surgeons for years now have railed against wicks, wicks which do not drain. A wick in a few hours becomes clogged with the coagulation of blood, lymph, and pus, and becomes more of a plug than a drain. Removal of such a wick twelve to twenty-four hours after its insertion is frequently followed by a gush of retained pus. Coagulation and crust formation are the foes of good drainage and have led to the expressions, "Let your drainage be efficient," "Make a surgical incision," and "Whatever you do, do not make a *medical* incision." Nature's way of draining an abscess through a small hole is for all reasons the best if the free flow of pus can be maintained.

The essential factor to limit or to begin the "cure" of an abscess is free bathing of the bacteria in the walls of the cavity with fresh serum from the blood, with its high antitrophic power. If such a free bathing of serum can be made continuous without introducing hemorrhage or causing injury to the tissue, here indeed would be for the first time a rational method of dealing with localized infection.

Wright's salt and citrate solution seems to fulfil these requirements. Sodium citrate (1 per cent.) in the solution

causes a precipitation of calcium salts in the lymph, removing thereby that which is essential to coagulation. The presence, then, of the sodium citrate in the wound cavity ensures a comparatively free exit of the lymph discharge. The sodium chloride, in hypertonic solution (4 per cent.), by osmosis brings about a flow of lymph through the walls of the cavity, the sodium citrate having dissolved clot and prevented further coagulation. Thus there is brought about a continuous pouring forth of lymph of high antitrophic power from the blood stream and lymph spaces, through the walls of the abscess cavity and out through the wound. The 4 per cent. solution is in itself antiseptic since bacteria will not grow in it.

PRACTICE.

To Sanborn of Boston is due the introduction of Wright's solution into our practice.

Conclusive evidence that the salt and citrate solution as a dressing and irrigation contributes to the destruction of bacteria in the walls of the abscess cavity has been, and may be at any time, obtained in the laboratory.

A patient came to the clinic for treatment of an infected wound of the thumb, the result of operation for a streptococcus infection on the previous day. When first seen, in the wound was a thick coagulated mass of pus and lymph, which obstructed all flow. The patient had a temperature and the local condition showed swelling, tenderness, and was the cause of much pain. In order to test as to whether the phagocytic activity beneath this crust was at all efficient, the crust was removed and smears were made from the fluid expressed at the base of the wound. It was found that most of the phagocytes were disintegrated, but that some appeared to be normal. It was only in the rarest instances that the streptococci were to be demonstrated within a leucocyte, but, on the contrary, there was a profusion of streptococci growing in long chains outside the phagocytes. The patient was given a small inoculation of vaccine, and a dressing of sodium citrate and sodium chloride was applied to the wound. The patient was told to soak the thumb one hour out of four until the next day, and

between times to apply hot poultices of the same solution to the lesion.

On the following day, macroscopically, there was an entirely different picture. The thumb was less red; there was free discharge and an absence of crust. The temperature was normal. A smear from the lymph, expressed in the same manner from the depths of the cavity, showed a striking difference from that seen on the previous day. No broken-down leucocytes were to be seen. In practically all the leucocytes were found many inclusions of streptococci in pairs and in short chains, while outside the leucocytes there were no long chains to be seen and cocci were only occasionally found.

TECHNIC.

The abscess is opened by a wound as small as will allow the cavity to be wiped out, or thoroughly emptied by expression. The skin round the wound is thoroughly cleaned with 70 per cent. alcohol. The skin in this region, up to the very mouth of the wound, is smeared with boric acid or eucalyptus vaseline. If the skin tension closes the lips of the wound a bit of rubber dam may be put in. The wound is covered with a voluminous pad of gauze or of absorbent cotton covered with gauze, dripping wet with hot salt and citrate solution. A many-tailed bandage or some other application holds the poultice in position and the part is put at rest. Outside the dressing may be applied a hot flax-seed poultice or a hot-water bottle. In any case, as often as the dressing gets cold more of the hot solution is poured over the whole dressing to wet and warm it again, or the dressing is removed and the whole part is soaked, if possible, or bathed with the same solution.

PRECAUTIONS.

The amount of sodium chloride in this solution is such that it will irritate the skin and lead to pustulation in a few days. Hence the frequent application of protective vaseline to the unbroken surrounding skin.

This solution is contraindicated if there is a tendency to persistent oozing of blood from the wound. It is also contra-

indicated where the formation of protective adhesions is desirable, as in certain abdominal wounds just after operation.

The solution should be used only for the first 36 to 72 hours after operation, during the acute stage of the inflammation. If longer used it leads to maceration and indolence in healing.

Two years of experience has amply proved the value of this solution. In office practice an abscess is opened, a small piece of rubber dam is inserted or not, a dressing with the inner layers wet with glycerin applied, and the patient is then given a recipe for one or more ounces of sodium citrate. He is told to go home, to add to a glass (eight ounces) of hot water about two and one-half teaspoonfuls of common salt and a large teaspoonful of the sodium citrate. With this solution he is to keep the dressing on his septic wound constantly wet and warm. Inguinal and axillary bubo, abscess of neck, septic fingers, mastoid wounds, otitis media after paracentesis, all drain most efficiently under this method. At the end of 36 to 72 hours the wound is filled with glycerin or balsam of Peru and is ready to heal.

THE RELATION OF THE DUCTLESS GLANDS TO SURGERY.*

BY J. E. SWEET, M.D.,

OF PHILADELPHIA,

Assistant Professor of Experimental Surgery in the University of Pennsylvania.

THE relation of any given subject to surgery is primarily and always—in the broad sense—precisely the same as the relation of that subject to the fundamental field of the philosophy of medicine. There are certain things, however, which bear a more particular relationship to some one or other of the various special branches; among those fields in which surgery should be especially interested is the problem of the function and the pathology of the ductless glands.

The problem bears a threefold relation to surgery. In the first place, the surgeon is often specifically concerned with the treatment of the pathological conditions occurring in these glands. A mere enumeration of these structures will suggest many such instances, like acromegaly and exophthalmic goitre; this physiologic group comprises the hypophysis and perhaps the pineal in the brain; the thyroid, parathyroid, and carotid gland in the neck; the thymus in the chest; the spleen and the adrenals in the abdomen; the lymphatic system. There are also certain ganglion-like structures in various parts of the body, belonging to the sympathetic nervous system, and grouped together as the chromaffine system. In addition to the true ductless glands, many, if not all, organs with distinct ducts have also an internal secretion which may be even more important than the external secretion; the internal secretion of the liver is of far greater importance than its external secretion of bile.

In the second place, the surgeon should have a special interest in all these glands of internal secretion, because it often

* Read before the Philadelphia Academy of Surgery, April 25, 1910.

requires a mastery of surgical technic to make possible an approach to the study of their function. An excellent example of this is the recent work of Cushing on the pituitary gland. Or, again, because of a surgeon's familiarity with the pathological picture, he may have acquired a peculiar position of authority in the study of the etiology of these conditions: an example of this is the work of Bircher on the etiology of goitre.[1]

The last element in this threefold relation of these structures to surgery is the one to which I would especially call attention, a relation which, it seems possible, may exist in the practice of general surgery. I refer to the relation of that group of structures known as the "chromaffine" system to the blood-vascular apparatus, and specifically to blood-pressure. The term "chromaffine" is derived from the presence of certain cells which possess a peculiar affinity for the salts of chromic acid; in the case of the adrenals, it is considered satisfactorily demonstrated that these cells are the ones which contain the pressor substance characteristic of the gland. The chromaffinity of these cells is therefore taken as the index of the functional state of the gland, although a fair doubt of the correctness of this assumption may be entertained.

It is not within the scope of this paper to enter into a discussion of blood-pressure, because it is such a complicated problem that it cannot be handled at all unless exhaustively. For the purpose of the present argument, we will therefore leave out of consideration all the factors concerned in blood-pressure except three, which three, it so happens, are also the factors which must probably be most important in a given space of time, such as a surgical operation. These factors are: first, the vasomotor centres in the brain and cord; second, the paths along which the power generated in the centres is transmitted, the vasomotor nerves; and, third, the mechanism by which the power generated in the centres, and transmitted by the nerves, accomplishes work.

For our present purpose we may define blood-pressure as the result of an opposing of a resistance to the force of the

heart-beat; variations of pressure are brought about by varying this resistance. It is generally held by physiologists that the chief resistance to the blood flow is offered by the arterioles and not by the capillaries: changes in the calibre of the arterioles will greatly vary the resistance, and therefore the blood-pressure. These changes of calibre are made possible by the coat of smooth muscle-fibres which surrounds the arterioles. These muscle-cells are in a condition of semicontraction known as "tone," and they are kept in this state by factors entirely apart from the nerve-centres of the brain or cord.

If I may be pardoned a homely simile in order to make my point of view perfectly clear,—no matter how perfect the construction of the engine, no matter how correct the system for the transmission of power, the engine will probably saw no wood if there be no saw for it to turn; and if a saw be present the total efficiency will depend as much upon the condition of the saw as upon the perfection of the engine. To transfer these terms,—the vasomotor centres may be efficient, and the nerves may be normal, but the musculature of the arterioles may not be able to respond. No theory of shock can be complete unless all these factors are given their due consideration.

The result of the experimental removal of the adrenals as well as the study of cases of pathological destruction of the glands, in Addison's disease, shows that the internal secretion of the adrenals is directly concerned in maintaining the tone of the vascular system. It is for us immaterial whether the adrenalin act directly upon the muscle-fibre or upon the end-plates of the nerves within these fibres.

Within the past few years there have appeared several articles in which the authors have presented the results of studies of the effect of narcosis upon the adrenals, and of studies of the adrenals in cases of death due to narcosis. It is to this relation of the chromaffine system to general surgical practice that I wish to call your attention. In the course of our study of the interrelation of the internal secretions, Dr. Ralph Pemberton and I have had occasion to keep dogs under ether anæsthesia for long periods, as also to extirpate one or both

adrenals in addition to long periods of anæsthesia. We have not been in a position to systematically study all our experiments from the stand-point of the effect of ether narcosis upon the chromaffine system. Our observations have, however, led me to feel that the results obtained by others are, in the main, correct. I have also been able to prepare a few specimens and tracings for demonstration.

Wiesel [2] found in a number of cases of status lymphaticus an extraordinary hypoplasia of the chromaffine tissue. This finding was confirmed on a large material by Hedinger.[3] The fact that the status lymphaticus renders the patient especially susceptible to accidents of narcosis led Schur and Wiesel [4] to an experimental study of the effects of narcosis upon the chromaffine system. They found that the specific cells of the medulla of the adrenals showed a progressive loss of affinity for chromic acid salts, this decreased staining reaction becoming more marked as the time of narcosis lengthened until, after three to five hours of narcosis, no more chromaffine cells were found; synchronous with this loss of chromaffine substance was the disappearance of the mydriatic action of extracts of such adrenals on the enucleated frog's eye, and the disappearance of the iron chloride reaction. If the animals were allowed to recover from the narcosis, the chrom-reaction reappeared, the time of reappearance varying, until from eight to twelve hours later the cells possessed their normal affinity for the chromic acid salts. The extract of an adrenal after five hours' narcosis showed no physiologic effect in one experiment. The result was the same with either ether, chloroform, or Billroth's mixture.

Parkinson [5] states that he found no chromic acid reaction in the medulla of the adrenals from two cases of postoperative shock.

Hornowski [6] found in four cases of postoperative shock a condition similar to that reported by Parkinson. His experimental results are practically the same as those cited from the work of Schur and Wiesel. Hornowski's most interesting conclusions are the following: "Chloroform increases the need for tonic substance, and at the same time causes an exhaustion of the chromaffine system, which may cause death." "Chloroform does not cause an immediate exhaustion of the tonic substance, but grad-

FIG. 1.

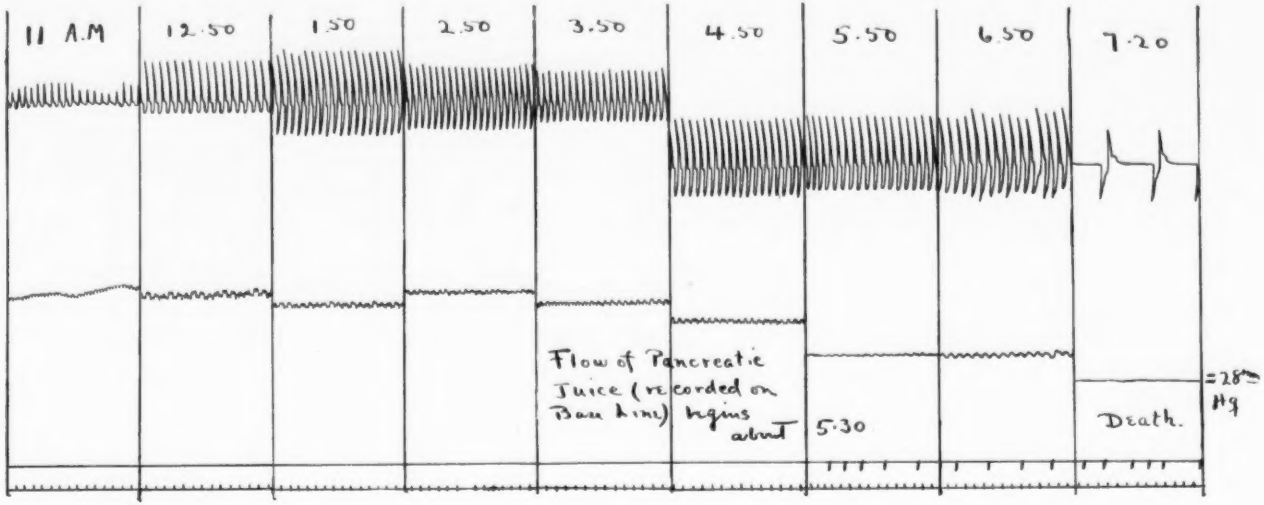
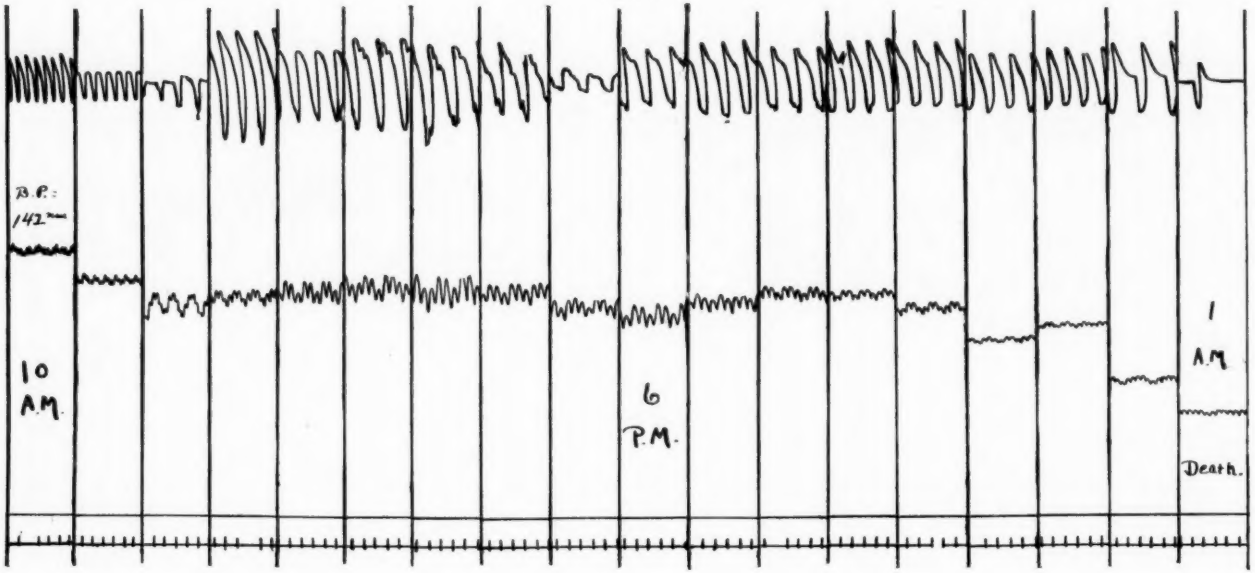

11 A.M
12.50
1.50
2.50
3.50
4.50
5.50
6.50
7.20
Flow of Pancreatic Juice (recorded on Bain line) begins about 5.30
Death.
=28 Hg

FIG. 2.



ually, after several hours." "Chloroform may cause a sudden exhaustion of the chromaffine substance if it be not present in abundance." "The resistance of the organism to surgical shock is expressed in the possibility of satisfying a greater need for tonic substance, and in the ability of the organism to secrete it."

Kostlivy [7] reports two cases, one of death occurring 72 hours after narcosis, in which the chromaffine substance was found intact; this result he explains in the sense of a regeneration, following Schur and Wiesel. A second case in which death occurred 24 hours after narcosis showed no demonstrable chromaffine substance.

Schwarzwald [8] concludes from a study of ten cases of death during and after narcosis, in seven of which the chromic acid reaction of the adrenals was found intact, that the question of the integrity of the chromaffine tissue under the influence of narcosis does not possess decisive importance. It must be added, however, that in three of these cases fatty degeneration of the heart was noted, and a fourth was operated upon while in eclamptic coma.

Kahn [9] endeavors to prove by extensive experiments that the work of Schur and Wiesel is based upon untrustworthy technic, and that therefore their results are incorrect.

A fairly extensive series of tests with the enucleated frog's eye, carried out by Dr. Pemberton and myself in connection with another phase of our work, led us to a conclusion in full agreement with Kahn, that results obtained by this method are not dependable; yet the results seem sufficiently accurate to enable one to draw such a general conclusion as the one that narcosis affects the adrenals. At the same time it is also fair to criticize one part of Kahn's own work. He made extracts of the adrenals after narcosis and found that they always gave a positive physiological reaction, but he used no norm for comparison. It is in such experiments a question of the amount of pressor substance as compared with some normal standard, not of its absolute loss. Dr. Pemberton and I have often observed in the normal animal that the ether must be pushed beyond mere anæsthesia before an effect upon blood-pressure is obtained, so that five hours' narcosis may not have meant the same thing in the experiments of Schur and Wiesel and those of Kahn.

In reviewing the notes of the work with Dr. Pemberton, I find of our last ten experiments, in which special attention to the condition of the adrenals was directed at autopsy, nine are noted as having the gross appearance you will see in the Kaiserling preparations,—the medulla is darker in color than normal, and around the circumference of the medulla are hemorrhages which extend radially a slight distance into the cortex, giving the organ a striated appearance. In one experiment the macroscopic appearance is noted as normal. I have made a few extracts of such adrenals, and in one instance it was evidently much less active than an extract of the adrenal from a normal dog; in another no marked difference could be seen.

Nevertheless, in spite of the fact that part of the technic used by Schur and Wiesel has proved unsatisfactory in our hands, and that the reaction to chromic acid salts may be uncertain or at best may not necessarily show the condition of functional efficiency, I still feel that the facts brought out by Schur and Wiesel and Hornowski are correct. This feeling is based upon the results we have obtained by the use of entirely dissimilar methods.

The most satisfactory proof I have seen that narcosis affects the adrenals is, first, in a comparison of the curve of the blood-pressure of a dog under ether with that of a dog from which the adrenals have been removed. In both there is the same gradual, progressive fall of pressure, occurring sooner in the dog from which the organs were removed; the time of fall in the normal dog can be hastened by increasing the rate at which the ether is administered. And, second, in our study of the interrelation of the glands of internal secretion, Dr. Pemberton and I have found that the pancreas begins to secrete after the removal of the adrenals, and may show an astonishing secretory activity over a long period until the animal's death. This fact, together with the fact that adrenalin inhibits the flow of pancreatic juice which follows the intravenous injection of secretin, leads us to conclude that the adrenals exercise some sort of control over the pancreas. In the etherized normal dog

this flow has never appeared; but there may, and often does, occur in the last minutes of life after prolonged etherization a flow of pancreatic juice, which we are inclined to feel indicates that the adrenals have been so affected by the narcosis that they have lost their control over the pancreas,—in other words, that the adrenals are exhausted.

In all our experiments we have a continuous record from the beginning of the experiment until the end, of the respiration, the blood-pressure, and the time in seconds, as well as the flow from the pancreas whenever it occurred. The only characteristic feature, aside from the flow of pancreatic juice in those cases where it occurs, is the gradual but progressive fall of blood-pressure; in some instances where a valvular heart lesion was found at autopsy, the addition of ether may be seen to cause sudden falls of pressure, which may sometimes be immediately fatal.

It is in regard to this point that the experience and more careful observation of the surgeon is needed to a proper elucidation of the problem. It should be perfectly evident that a change in the adrenals would not be expected in every case of sudden death during or after narcosis. It is astonishing to note that Schwarzwald included three cases of fatty heart, and one of eclamptic coma. I am of the opinion that the term "shock" should be more strictly used, and should only apply to those cases where neither the case history nor an autopsy reveals any other cause of death save the progressive fall of blood-pressure.

At the same time the solution of our problem must await a satisfactory laboratory method for determining the functional efficiency of the adrenals. It does not appear to me that a staining reaction is necessarily indicative of functional efficiency; as we have seen, the mydriatic reaction, as tested upon the pupil of the enucleated frog's eye, is unreliable for quantitative tests; the iron chloride and the sublimate reactions are of doubtful value; and even the physiologic test of extracts of the organs does not prove the point; for the amount of adrenalin is not the only variable,—the susceptibility of the

musculature to the action of the adrenalin may be variable, so that what would be a functional adrenalin content of the gland in one animal would not suffice to maintain the vascular tone of another.

Two points stand out from the somewhat indefinite condition of the problem of the relation of narcosis to the chromaffine system; first, the necessity for an accurate clinical classification of cases of death due to narcosis; second, the hope that a rational treatment of cases of shock—the prophylactic treatment—may soon be materialized.

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[8] *Loc. cit.*
[9] Pflüger's Archiv, 1909, cxxviii, 519.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY.

Stated Meeting, April 27, 1910.

The President, Dr. Ellsworth Eliot, Jr., in the Chair.

BONE METASTASIS IN A CASE OF HYPERNEPHROMA.

Dr. E. H. Pool presented a man, 57 years old, who was transferred from the medical service of the New York Hospital to the service of Dr. Frank Hartley on February 15, 1910. For three months prior to admission he had suffered from moderate pain in the calf of the right leg. Soon after the pain began, he noticed a swelling just below the knee, which steadily increased in size. He had no symptoms referable to the abdomen or elsewhere.

Examination on admission showed a rounded swelling, about two inches in diameter, on the outer part of the right leg, over the head of the fibula. The skin covering it was slightly reddened, movable, and not tender. The tumor was rounded, smooth, and immovable, and evidently involved the head of the fibula. It gave a marked expansile pulsation; its size could be diminished by pressure, and the pulsation was controlled by pressure upon the popliteal artery. There was no thrill nor murmur. The knee-joint was normal; there were no enlarged inguinal nodes.

The heart was slightly enlarged, and there was a systolic murmur heard at the apex. The arteries were sclerotic. Physical examination was otherwise negative. The urine was clear, acid; specific gravity, 1010; it contained a trace of albumin and a few leucocytes.

The tumor was diagnosed as a sarcoma of the fibula, and on February 18, Dr. Pool resected the upper third of the fibula, together with the muscles attached near its upper end. The external popliteal nerve was dissected free and preserved. The head of the tibia was likewise removed as far as possible without

opening the knee-joint and weakening the bone. The wound healed by primary union, and the patient could soon walk with comfort. The growth, which measured about one inch in diameter and was for the most part encapsulated, involved the whole head of the fibula; it infiltrated the muscles to a very slight extent, and at one point reached the head of the tibia. It was grayish-red in color, very vascular, and of soft consistence. The growth was submitted to Dr. Elser, who reported that the microscopical examination revealed the typical picture of hypernephroma.

As a result of this report, renewed efforts were made to palpate the kidneys, but only a doubtful feeling of resistance could be made out over the lower pole of the right kidney. The X-ray failed to reveal anything abnormal, in or near the kidney. Cystoscopic examination of the bladder made by Dr. A. S. Taylor was negative. The ureters were catheterized, but the urines showed no notable differences: methylene blue, injected subcutaneously, appeared in the left urine in nine minutes and in the right in fifteen minutes, showing delayed secretion on that side. Red cells had been present in the urine in several subsequent examinations.

Exploration of the kidney was not done on account of the patient's poor general condition and his opposition to another operation. Weekly examinations since his discharge have revealed a rapidly growing tumor in the region of the right kidney, which was now very extensive. It was hard and nodular to the feel. The patient had lately begun to suffer from weakness, loss of appetite, and severe abdominal pains.

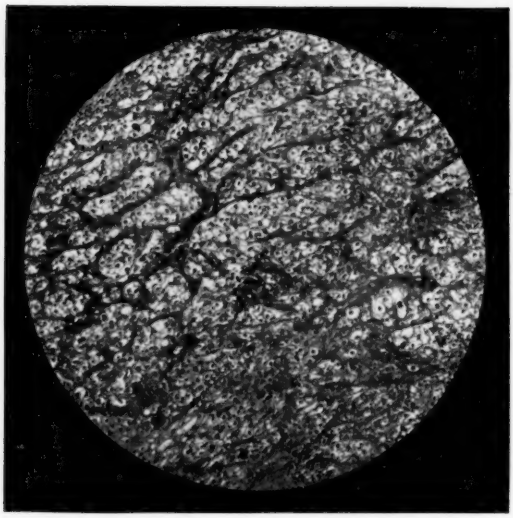
GANGRENE OF THE LUNG.

Dr. James M. Hitzrot showed two patients. The first case was a man, 34 years old, a laborer, who was admitted to Dr. W. Gilman Thompson's service at Bellevue Hospital on February 16, 1910. He complained of shortness of breath and pain in the right chest, which was increased by breathing. Eleven days before admission he had suffered from severe shooting pains in the right chest, which kept him from work, had a dry cough, had expectorated a little blood, and felt weak and sick. On admission, his temperature was 103°; pulse, 120, regular. There was dulness over the left lower chest, with bronchial breathing, but no tactile fremitus behind. Upon aspiration, a syringeful of

FIG. 1.

Hypernephroma of head of fibula.

FIG. 2.



Microphotograph of bone metastasis of hypernephroma.

brownish, stinking fluid was removed. A blood count showed 45,000 white blood-cells, with 79 per cent. polynuclears.

The patient was transferred to Dr. George Woolsey's service. Operation, by Dr. Hitzrot: By aspiration, pus could be obtained only in the eighth interspace below the angle of the scapula. Under local anæsthesia, an incision was then made along the line of the eighth rib, and three inches of the rib were resected, exposing a cavity containing stinking pus and broken-down lung tissue, which came out of the chest opening in large pieces. Two rubber drainage tubes were inserted.

Following the operation, the patient's temperature ranged from 100° to 102°, falling to normal on the forty-second day. During this time, the wound had discharged foul smelling detritus; it ceased on the forty-fourth day, and now, seventy days after the operation, it had healed excepting for a slight sinus in the skin. The open-air treatment on the balcony of the hospital was followed throughout his illness. Cultures from the pus taken from the chest showed streptococci.

Dr. Hitzrot's second case of gangrene of the lung was in a man, 34 years old, who was admitted to Dr. Thompson's service in Bellevue Hospital on February 11, 1910, complaining of pneumonia. Three weeks before admission the patient had had a severe pain in the left chest, with a chill, and a dry, hard cough. Instead of improving, he had gradually grown worse during the past week. His cough had become loose, and the expectoration was profuse and very foul smelling. The pain in his chest had also become more severe, and he now had pain over the entire lower back on the left side, especially to the touch.

On admission, the patient's temperature was 105°; respirations, 40; pulse, 140. He was cyanosed and expectorating large quantities of foul-smelling fluid which separated into the three characteristic layers. His breath was extremely fetid, the odor of it filling the entire ward. Expansion was limited over the entire left back, with flatness below, and diminution of the breath sounds over the flat area. Splashing was elicited upon shaking the patient. The chest was aspirated in the eighth interspace below the left scapula, and a syringeful of stinking fluid and air were removed.

The patient was transferred to Dr. Woolsey's service, and operated upon by Dr. Hitzrot under local (novocaine) anæsthesia,

three inches of the eighth rib being resected. The submuscular layer was filled with stinking pus, and a perforation in the pleura between the eighth and ninth ribs gave vent to foul fluid and air. The pleura was incised, and a large quantity of broken-down lung tissue and fluid of a very foul odor was allowed to escape. With each respiration, air entered the chest, and the finger could just reach a fairly large bronchus, the touching of which caused a paroxysm of coughing.

Numerous counterincisions were made to drain the submuscular space. Following the operation, the patient's temperature ranged between 100° and 103°, falling to normal on the forty-eighth day, at which time the discharge had ceased. Permanganate solution introduced into the chest was coughed up immediately. The wound had now healed, excepting for a slight sinus, through which air escaped, especially on coughing.

Smears from the fluid showed a varied bacterial flora, among which were numerous *streptothrices*. The culture was unfortunately lost. No tubercle bacilli were found in either case, and both showed a chest exudate originating from a necrotic process in the lung, probably postpneumonic. In the second case, this connected with a large bronchus. The diagnosis of gangrene rather than abscess was based upon the foul character of the exudate, and the sloughing cavity in the lung.

Dr. George Woolsey said a particularly interesting feature in both of these cases was the improvement that followed the balcony treatment—keeping the patients in the open air. In that environment they felt and looked better, their temperature dropped, and at the present time, from the appearance of the patients, they seemed to be in the best of health.

EXCISION OF THE RECTUM FOR CARCINOMA BY THE PERINEAL ROUTE.

Dr. Charles H. Peck presented two cases to show the local result of resection of the rectum by the perineal route. In neither case was the condition in a sufficiently early stage to give much hope of an ultimate cure of the disease. In the first case, a deeply ulcerated growth which had already extended into the perirectal tissues posteriorly was discovered in the course of an examination for another condition, namely, right hydronephrosis, with movable kidney, and careful questioning showed that

rectal symptoms had been present for many months. A further delay of two months was caused by the patient's refusal to submit to operation. In both cases the growth was low in the rectum, so that the only difficulty of carrying the dissection wide of the disease was in its immediate vicinity.

The first patient had little or no true control, as the low position of the growth necessitated the sacrifice of a large part of the sphincter, but a constipated habit kept her from soiling excepting after catharsis. She was 60 years of age, and was operated on at the French Hospital on October 27, 1909. The technic was essentially that described in detail in the two cases presented to the Society by Dr. Peck in November, 1909. Ulceration had extended practically through the rectal wall posteriorly, and there was some leakage before the growth could be excised, in spite of careful manipulation. About five inches of gut was removed, including the posterior portion of the sphincter. The tape ligature was left on the proximal segment after the usual anchorage within the denuded sphincter and wound closure. No leakage occurred for sixty-six hours, when the insertion of a trocar to allow the escape of gas became necessary on account of distention, and the following day the ligature was cut away.

The wound healed slowly, with but slight infection, and the patient left the hospital on December 20. Dr. Peck did not see her again until April 25, six months after operation, when examination showed a well-marked cicatricial stricture just above the anal orifice, and a suspicious nodule posteriorly, where the growth had originally invaded the perirectal tissues. She had gained a good deal in weight, and her general condition had greatly improved. The local result was far from ideal, but still it was a marked improvement over her condition at the time of operation.

The second patient, Mrs. A. B., aged 63 years, had noticed blood and mucus in her stools for nine months, with severe pain in the rectum, and tape-like stools for four months. The pain was especially severe on defecation and on sitting down. She had lost about twelve pounds in weight during the preceding six months. The patient was operated on by Dr. Peck at Roosevelt Hospital on February 24, 1910, for the removal of a growth which commenced about two inches above the anus and involved fully three inches of the length of the gut. The sacral glands

were invaded, and there was some adhesion to the vaginal wall. The growth and glands, together with from an inch and a half to two inches of healthy gut above the growth, were excised. The technic of the operation was similar to that already described. The growth proved to be a very cellular adenocarcinoma, with glandular involvement.

Healing was prompt, with practically no wound infection. The gut was left closed ninety-two hours, when spontaneous leakage occurred at the anal margin, and the tape was cut away. The patient left the hospital thirty days after the operation with the wound perfectly healed, and with some degree of sphincter control already established.

The ligation of the gut, Dr. Peck said, was a distinct aid in avoiding wound infection. The fact that it prevented suture of the mucous membrane to the anal margin, and that the sloughing of the projecting portion was apt to extend a little above the sphincter posteriorly, probably added to the danger of anal stricture to some extent, but that had not been an especially troublesome feature in the cases which he had done, the most marked example among them being Case I, presented at this meeting. In a third case done within the past few months, in which the growth was higher up, sloughing of several inches of the gut necessitated a second operation for the formation of a permanent inguinal anus.

PERFORATING DIVERTICULITIS OF THE SIGMOID.

Dr. Howard Lilienthal showed a man, 45 years old, who was admitted to the Mt. Sinai Hospital on March 23, 1910. His past history had no bearing on his present illness, which began about eighteen months ago, when, soon after a meal, he had a feeling of distention of the abdomen, especially in the left iliac region. At that time he was confined to bed for several weeks and had a slight elevation of temperature. A mass of considerable size was felt in the left iliac region, which gradually disappeared. It recurred, however, and at the time of the patient's admission to the hospital it could be distinctly made out. It was quite hard, and adherent to the abdominal wall. The patient's temperature at this time ranged between 101° and 102°, and he did not have the appearance of a very sick man. The intra-abdominal growth was regarded as an abscess, probably a diverticulitis, or a slowly developing perforation in the wall of the sigmoid.

Operation.—An incision was made through the left rectus rather low down, exposing the sigmoid, the upper portion of which was very much congested and thickened. It was tied down by a large omental mass, in separating which he encountered a small abscess cavity containing very foul pus. He separated the omentum and removed a considerable part of that portion which had been adherent to the sigmoid, coming down upon two very well marked diverticula; one of these was quite long, and communicated with the abscess. Several other diverticula were present but they were not inflamed.

The entire coil of intestine was so much thickened and so friable that it was thought wise to partially exclude it. A side-to-side anastomosis was made, and the diseased loop of intestine was side-tracked, and the wound drained through the flank. The patient made a good recovery, and the flank wound which communicated with the inflamed loop of intestine healed almost immediately.

The interest of this case, Dr. Lilienthal said, aside from its being a case of diverticulitis which was diagnosed beforehand, lay in the manner of dealing with it. The damaged loop of intestine might have been excised, but that would probably have been a dangerous procedure under the circumstances. The speaker believed that the lateral anastomosis had much to do with the patient's prompt recovery. From the location of the anastomosis, and from the fact that the drainage opening to the diseased coil closed so rapidly, he was convinced that the anastomosis was now carrying on the principal work of the intestine and was draining the diseased part.

Dr. Robert T. Morris asked Dr. Lilienthal whether the incision he had made in this case gave him the best access to that region. Personally, he preferred a gridiron incision, corresponding to the appendix incision on the right side.

Some of these cases, Dr. Morris said, might be treated conservatively. In one case where he was called upon with a view to operation, the patient had a large, distinct mass of exudate, but as he was apparently improving, it was decided to wait, and at the end of three weeks the mass was absorbed. In another case where the patient suffered from a dilated heart without compensation, there was a large intra-abdominal exudate which became absorbed without abscess formation. In all probability,

the speaker said, exudates in this region underwent absorption rather more safely than in some other parts of the abdominal cavity, although waiting for absorption was not to be advised, because the original defect would be left after recovery from any one acute attack. There were unusual reasons for waiting in these two cases quoted.

DR. LILIENTHAL, in closing, thought the case might have been cured without resorting to a lateral anastomosis, but at the same time the appearance of the intestine was not particularly favorable, and there were two or three areas that looked as if they might perforate. At any rate, it appeared to him that a lateral anastomosis promised the best drainage. The anastomosis was completed very quickly, taking only a few minutes, and ample drainage was thus afforded to the abscess and to the damaged loop of gut. As to the choice of incision, Dr. Lilienthal said that in approaching the sigmoid he usually went through the rectus; he preferred this to the gridiron incision, which was too far to one side.

A CASE OF CIRRHOSIS OF THE LIVER IN WHICH THE TALMA OPERATION WAS DONE NINE YEARS AGO.

DR. GEORGE WOOLSEY showed this case. The patient was a man, 68 years old, who was operated on in 1901, nine years ago. About five weeks prior to his admission to the hospital at that time he had noticed increasing swelling of the abdomen, with some difficulty in breathing. The arteries were slightly thickened; his appetite was good. Upon examination, the liver could be felt three and a half inches below the ribs; the spleen was not palpable. The abdomen at the umbilicus measured 110 cm.

Upon opening the abdomen, the liver was found hob-nailed; the omentum was thickened, and the superficial abdominal veins distended. The abdominal cavity contained a large quantity of fluid; this was evacuated, and the omentum was sutured to the peritoneum, the typical Talma operation being done. A second opening was made above the symphysis for drainage.

After the operation, there was a reaccumulation of fluid, necessitating three or four tappings, but at increasing intervals. Finally, there was no further reaccumulation of fluid. The patient resumed his occupation and was able to work until September, 1909. He was then in Florida, and had a severe attack

of malaria. About this time his abdomen again became swollen, with increasing shortness of breath and loss of weight and strength. Paracentesis was performed and had been repeated several times since.

Dr. Woolsey said the interest in this case lay in the fact that this patient had enjoyed such a long period of immunity from a recurrence of his ascites, namely, from April, 1901, to September, 1909.

Dr. Lilienthal said that a few days ago he was asked to operate on a case of supposed cirrhosis of the liver, of which the patient gave every evidence. The belly was enormously distended with fluid. There was no jaundice. Upon opening the abdomen, he came down upon an extremely contracted liver, which was evidently carcinomatous. The abdominal cavity was filled with a straw-colored fluid *not* in the slightest degree bloodtinged. After removing a small specimen from the liver, the wound was closed, and the man died a few weeks later. The fluid in this case, Dr. Lilienthal said, was collected in order to use it in other cases of carcinoma, after the manner suggested by Hodenpyl. The case was one of primary carcinoma of the liver, involving the liver-cells, and the entire liver was carcinomatous from one end to the other. The organ was very much contracted, and the carcinoma was probably on a cirrhotic base. The spleen was not involved. Cases of this kind were very unusual.

THE TREATMENT OF LARGE ANEURISMS WITH GOLD WIRE AND ELECTROLYSIS, WITH REPORT OF A CASE: EXPERIMENTAL RESULTS.

Dr. William C. Lusk read a paper with the above title.

Dr. Woolsey said he did not understand the advantages of the gold wire over an alloy of silver and copper. In one case (reported in Vol. xxxii) where he had employed this method with a somewhat stronger current, the patient had three aneurisms, and the wire was introduced into the middle sac, which was the largest of the three. A clot was readily produced, but as this contracted, the blood again had free access to the outer or traumatic sac and the man ultimately died from rupture of this sac. What was desired in these cases was to get an adhesion of the clot to the aneurismal wall; otherwise, when the clot contracted,

there was a space between the clot and the wall. Such adhesion did not occur except when the intima was altered by the current passing through the wire where it was in contact with it.

DR. ELIOT asked Dr. Lusk if he had ever found any indication of embolism resulting from any method of treating aneurism, either by ligation or electrolysis.

DR. LUSK replied that a case of embolism following the wiring operation had been reported by Salinger.

CONGENITAL MACRODACTYLIA.

DR. POOL showed the specimen in this case, upon which he operated at the French Hospital in June, 1907, for macrodactylia and diffuse lipoma of shoulder and arm. The patient was a boy, 2 years old, who was born with a very large right index finger. When the child was about 18 months old the mother also noticed enlargement of the right arm and shoulder.

Physical examination showed a healthy boy, normal in every respect excepting the right upper extremity. The outer parts of the shoulder, arm, and forearm were greatly enlarged by a diffuse lipoma. The index finger was about twice the normal size, the nail being correspondingly enlarged. These features were shown in the photographs.

The index finger was removed at the metacarpophalangeal joint, and the most conspicuous parts of the lipoma were excised through elliptical skin incisions. Its outlines, however, were nowhere distinguishable. The wounds healed by primary union, and the boy was greatly improved in appearance.

Histological examination showed the tissues removed from the shoulder and arm to be lipomatous. The notable features in the examination of the finger were marked increase of subcutaneous fat and considerable increase in the breadth of the terminal phalangeal bone.

EPITHELIOMA OF BOTH UPPER JAWS AND MUCOSA OF UPPER LIP: RESECTION OF BOTH UPPER JAWS.

DR. L. W. HOTCHKISS reported this case and showed photographs illustrating the condition before and after the operation. The patient was a male Italian, 26 years old, who was admitted to Bellevue Hospital on February 9, 1910. His previous history was unimportant. About two months ago he first noticed a stiff-

FIG. 3.

Congenital macrodactylia and diffuse lipoma of upper extremity.

ness and thickening of the upper lip on its mucous aspect. At this time there was practically no pain. The swelling seemed to involve the gums, especially at a point where he had had three upper front teeth removed some years ago. Here there was slight swelling and some pain, and this point finally broke down into an ulcer, which gradually increased in size, involving the gums about the outer teeth, which fell out. The ulcer had been slowly increasing in size and involving more of the hard palate; it bled very readily, had a foul odor, and recently the pain at the site of the ulcerated area had been severe. The patient also complained of an almost continuous headache and pain in the back of his neck, with some stiffness. His appetite had been poor, and he had lost considerable weight, as he had been unable to eat on account of the condition of his mouth. The patient's general appearance was anæmic and wretched, the upper lip bulging, and the mouth emitting an extremely offensive odor. The growth bled very easily, and a considerable hemorrhage took place from the excision of a small bit of the tissue for microscopic examination.

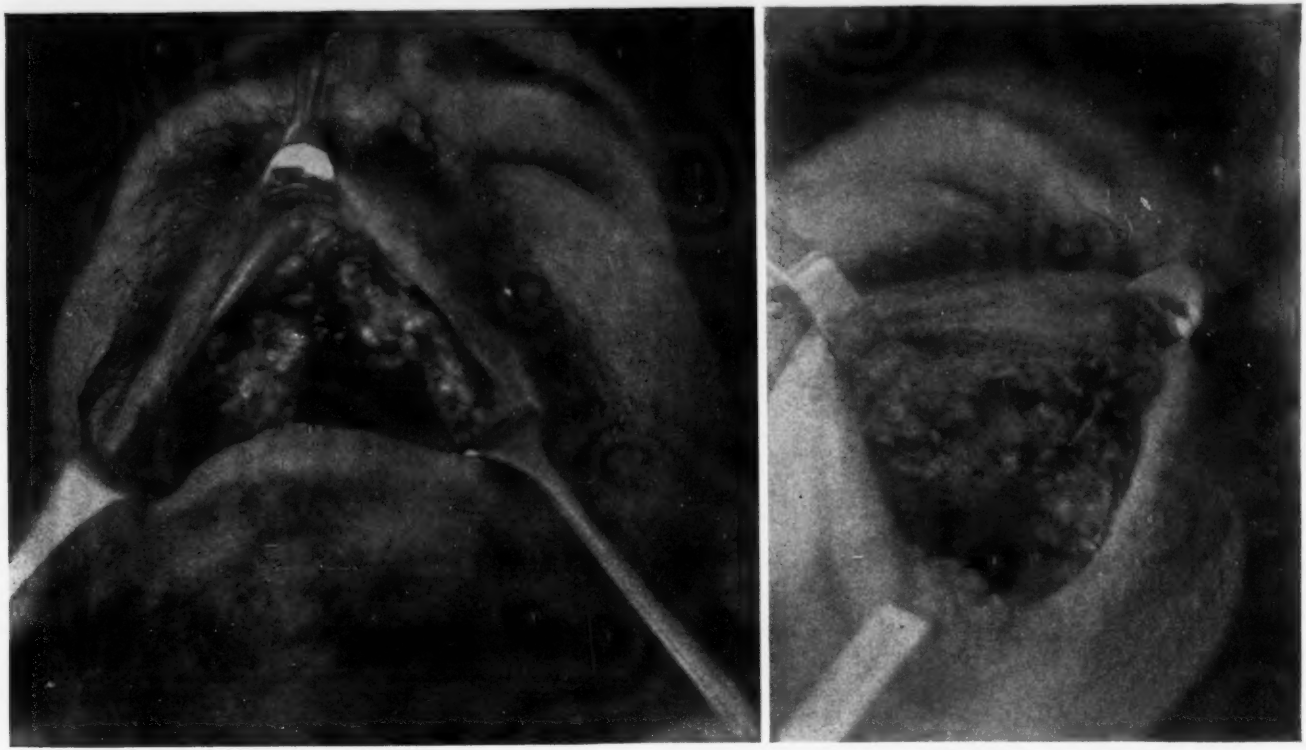
Operation (February 19, 1910).—Ether anæsthesia was employed, preceded by a small hypodermic of morphine and atropine. Drop ether with the mask was first used, and later the anæsthetic was given by Crile's method through nasal tubes. The usual Ferguson incision for the removal of both upper jaws was made, and the greater portion of the bodies and processes of both bones were removed, excepting the orbital plates. There was moderate hemorrhage, and no preliminary carotid ligation was done. The hard palate as far back as the palate process of the palate bone, a portion of the septum of the nose, and the lower turbinals were taken away, as well as most of the body of the bone. The affected mucosa of the upper lip was also excised, and the soft parts were brought together by silk sutures and covered with a layer of cotton and collodion dressing. The patient bore the operation well, considering his enfeebled general condition, and his convalescence was uneventful, barring the occurrence of a mild erysipelas of the nose and the adjacent part of the face.

There was only slight elevation of temperature after the operation; the patient rapidly gained in strength under systematic nasal feeding and he was soon up and about the wards. The power to hold food in the mouth and swallow without leakage

through the anterior nares was rapidly regained, and when he left the hospital on March 30, forty days after the operation, he could feed himself and eat solids and liquids with but very slight leakage. By this time the large cavity left by the operation had contracted considerably, and the deformity, as shown by the photographs, was very slight.

The patient was removed from the hospital by the authorities to be deported to Italy, so it would be difficult to find out how long an interval would elapse before a recurrence took place. It was certain, however, that the removal of the huge and foul, ulcerating mass from his mouth made him at least more comfortable. The photographs illustrate very well the situation and extent of the epitheliomatous growth, and the comparatively small deformity resulting from so extensive and mutilating an operation.

FIG. 4.



Epithelioma of hard palate and alveolar process.

FIG. 5.

Showing cosmetic result after removal of both upper jaws.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY.

Stated Meeting held April 4, 1910.

DR. ROBERT S. LECONTE, President, in the Chair.

EPULIS AND SARCOMA OF JAW.

DR. JOHN M. SPEESE read a paper with the above title, for which see page 493.

DR. W. M. L. COPLIN (by invitation) said with reference to melanotic tumors of the jaw that he had seen specimens from a number of these cases and did not know of a single one in which recurrence did not take place. Dr. Speese spoke of the prognosis based on histological examination. This may be possible if the tumor contains many giant cells, but when dealing with neoplasms composed of round or spindle cells the method becomes of doubtful value; it is probable that in these cases the outcome depends largely upon the resistance of the patient. Usually the paramandibular tissues are not involved early, a fact depending upon the architecture of the jaw, the periosteal and intra-osteal tissues acting as a filter that resists extension of the growth.

Another point worthy of attention is the relative immunity of the submaxillary and sublingual glands. Of the specimens which come to the laboratory for examination, he had seen one in which either a submaxillary or a sublingual gland was extensively invaded. He had seen the growth almost surround a salivary gland but for some reason or other it is rare to see it penetrating the lobes or even the interlobular tissues. In all neoplasms of the mouth the salivary glands are attacked late, if at all. He had never seen a telangiectatic sarcoma of the jaw in which there has been extensive ulceration, a fact for which a fully satisfactory explanation is wanting. The jaw enlargement is accomplished by internal osseous absorption and continual subperiosteal apposition. He had one specimen removed by Professor Hearn in which the involved area of the jaw was larger than

a fist, and still there was no sign of extension through the outer bony layer and no involvement of the soft parts; this tumor presented egg-shell crackling in a very marked degree.

Dr. A. P. C. Ashhurst inquired whether Dr. Speese had succeeded in following any patients treated by radical operation. It has been claimed by recent writers that it is useless to do a radical operation as the disease, if highly malignant, recurs in a few months and the patient dies; whereas an operation consisting in an evacuation and scraping of the tumor is sufficient in cases which are not so malignant.

Dr. John Speese rejoined that the diagnosis in most of the cases operated upon at the University Hospital had been made from the clinical appearance of the tumors, although in some instances frozen sections had been made when the growths had been soft and not infiltrated with lime salts or bone. In the central sarcomata, in three or four cases, the bone was trephined and sections taken for microscopic examination, the operative procedures being based upon the character of the growth, the giant cell tumors being treated by less radical measures than other types of sarcomata.

His experience agreed with that of Dr. Coplin for the salivary glands had been involved rarely in malignant disease of the mouth and jaw. Their records show that many of the periosteal and central sarcomata, both round and spindle cell in type, have been cured. The number of cases traced through the Surgical Laboratory does not permit him to state at present, however, the percentage of cures in the cases operated upon.

ENTEROPTOSIS.

Dr. George P. Müller reported a number of cases of enteroptosis, and remarked that the abdominal organs are held in position by the negative pressure of the thoracic cavity, the mutual support of the different organs, the peritoneal, ligamentous and vascular attachments, etc. If these are interfered with, ptosis will result, and such interference may occur from congenital or acquired causes.

The congenital type is usually seen in a thin, pale, young woman, of slight build, with a long sunken thorax, flabby abdominal walls, a juvenile expression and a bodily form exactly like that seen in the tuberculous. The tissues are inherently weak and fragile and the actual displacements occur from secondary causes

such as exhausting diseases, marked loss of weight, overstrain, lack of proper nourishment, constricting clothing, pregnancy, uterine affections, prolonged cough from bronchial affections, etc. The earlier manifestations are seen in the attacks of dysmenorrhœa and chlorosis that young girls experience and later the symptoms may be erroneously interpreted in such vague terms as neurasthenia, nervous exhaustion, chronic constipation and change of life. There is no essential difference between the symptoms due to a movable kidney, a retroverted uterus or a displaced colon except those dependent upon the drag on different anatomical supports, the general phenomena being the same.

The symptoms are referred to the digestive apparatus, the generative organs, the nervous system, or to the body generally; gastric hyperacidity, flatulence, constipation, vague abdominal pains, backache, pelvic troubles, leucorrhœa, headache, menstrual and vesical troubles, melancholia, nervousness, etc., are the most prominent symptoms and the patient complains of a total lack of energy, physical and mental. There is a lightness of weight and a general relaxation and flabbiness of the tissues.

Physically, the oblique slant of the ribs, the acute epigastric angle and the very long abdomen and small waist are characteristic. The tenth rib may be freely movable or floating (Stiller's sign). One or both kidneys are often palpable, the liver is displaced and its edge palpable, the stomach displaced and may be dilated, the colon and sigmoid are usually displaced and often redundant, the uterus may be retroverted or flexed.

A movable cæcum may produce symptoms indistinguishable in many cases from true appendicitis and Klose believes that in many of the cases of recurrence of trouble after operation without supposed chronic appendicitis a movable cæcum is at fault.

The *acquired type* is due (1) to rupture of the pelvic diaphragm from childbirth which, if extensive and not properly repaired, may after a time weaken the abdominal supports and not only the uterus but the intestines may become displaced; (2) to constipation, which by overloading the colon or sigmoid may directly induce ptosis; (3) by tight lacing which tends to force the intestines downward and loosen the liver; (4) to adhesions from inflammatory disease or from operations causing a drag upon the omentum, and by direct traction the colon is pulled downwards, and drawing upon the stomach it in turn is displaced.

No case of enteroptosis should be operated on until medical means have been exhausted without relief. The patient should be treated, if the displacement is of the congenital type, in exactly the same way as are tuberculous patients, and the outdoor life should be especially emphasized. The diet should be carefully regulated and food causing flatulence or constipation avoided. Certain drugs, especially tonics and laxatives, may be needed at times, but are of minor importance. The abdomen must be supported by an efficient bandage, and it is well to advise elevation of the pelvis for an hour or more before retiring. If the patient is young and the thorax movable she should be taught a system of breathing exercises in order to increase the capacity of the lungs and the size of the upper abdomen.

The question of when to operate is difficult to answer in the congenital type. In general, it may be stated, that if some one organ is markedly ptosed and the symptoms are especially referable to this organ, an operation should be advised, but if the kidneys, stomach, colon, uterus, etc., are all displaced and the symptoms general, operation only complicates the condition, and as Clark has said, "A pathologic condition may be left behind which imposes a still greater burden upon the defective dynamo and makes a more hopeless neurasthenic of the patient than ever."

The acquired cases, on the other hand, offer splendid opportunities for conservative surgery, the type of operation depending upon the condition causing the ptoses. Repair of the perineum, suspension of the uterus, shortening of the uterosacral ligament, suspension of the colon, of the stomach, and of the liver, are the operations most commonly practised. In addition to these the separated recti should be brought together by some operation such as Webster's. A large part of the fat may be excised from a pendulous abdomen, as recently practised by Howard Kelly, or the oblique muscles may be strengthened by some such operation as the one recently published by Coffey. In recent years a number of operators have proposed excision of part or all of the colon. Dr. Müller commends the excision of most of the transverse colon or of the sigmoid in selected cases as it undoubtedly will be frequently performed in the future, but believes that Lane's proposal to excise the entire colon and anastomose the ileum to the sigmoid is unnecessarily severe and certain of a high mortality. The operation of iliosigmoidostomy with exclusion of the

colon is not rational and will probably fall by the wayside, the experimental work being decidedly against its value.

Finally, he urged the necessity for caution in these cases, as too much operating can easily be done and the results if bad are almost irremediable. The surgeon should endeavor to grasp the salient points in the cases, repair the major lesion and trust to his after-treatment to finish the cure of his patient.

Dr. William L. Rodman said with regard to gastroptosis, he personally had believed it unwise to operate on the majority of these cases, yet there are exceptional ones demanding operation. He had recently encountered such a case in a patient referred to him by Drs. Anders and Pfahler. The patient was a small woman and the degree of dilatation and displacement of the stomach was so marked that the medical men considered that the case required operation. She vomited constantly, being unable to keep anything on her stomach. Dr. Pfahler had skiagrams made several years ago and some made more recently, indicating that the stomach was twice or thrice the size it should be. The stomach was so large that it was in the pelvis; this naturally produced a kinking at the pylorus, and interfered with the organ emptying itself. It seemed that nothing short of a pylorectomy would do any good. Between one-third and one-half of the stomach was removed and the remaining portion sutured to the parietal peritoneum or anterior abdominal wall. There has been a skiagram taken since the operation, a day or two before she left the hospital, which shows now the remaining part of the stomach in good position. She has not vomited since the operation; she is putting on flesh. This is one case in which operative interference was undoubtedly warranted.

We probably have been remiss in the past in not operating on more of these cases. Undoubtedly, however, the old rule that where there is general dropping of all the viscera operation is not indicated, holds good; but, where the ptosis is limited, operation is both desirable and advisable.

CHROMO-URETEROSCOPY IN FUNCTIONAL KIDNEY DIAGNOSIS.

Dr. B. A. Thomas read a paper with the above title.

Dr. Thomas further remarked that in chromo-ureteros-

copy it is desirable to insure a perfectly colorless fluid content of the bladder, and he believes this, in many instances, can be obtained only by prolonged irrigation. In bad cases of hæmaturia or pyuria it becomes positively essential. This can best be obtained and maintained by an evacuation cystoscope which permits of frequent and speedy evacuation and refilling of the bladder, because very frequently the bladder content may become clouded and it will be impossible to judge as to the character of the elimination of the dye. An absolutely brilliant illumination is necessary so that the landmarks in the bladder as well as a weak color reaction will be distinctly visible. If these two conditions are not secured, in certain cases where there has been chronic retention of urine or chronic parenchymatous nephritis, in which diseases the elimination of the indigo as a light blue will simply ooze out of the ureteral orifices instead of being ejected as a spurt, judgment of the test will be vitiated and conducive to erroneous conclusions.

It would be of value to one undertaking the work for the first time to have the history and know the physical examination of his case. So far as the results of the cases here reported are concerned, Dr. Thomas refers the questioner to a careful review of the charts, noting the time of elimination and color reaction in detail, for it was with respect to these observations alone, to prove their value or worthlessness, that the charts were compiled.

Annual Meeting held April 25, 1910.

The President, Dr. Richard H. Harte, in the Chair.

THE RELATION OF DUCTLESS GLANDS TO SURGERY.

Dr. J. Edwin Sweet read a paper with the above title, for which see page 545.

Dr. W. M. L. Coplin (by invitation) said that recently Caccio has published in Italian a paper on cellular lipoids in which he deals with the influence of the chromic acid salts on these bodies and suggests very strongly that there is some relation between chromaffine substance and the lipoids contained within certain tissue cells. Admitting the correctness of views which Dr. Sweet has given, concerning the influence of anæsthetics, then there is a chemical explanation for the observation brought for-

ward in his paper. If these substances are soluble in the agents used in anæsthesia, then, of course, one at once appreciates why they become so readily diffused, and why under such circumstances exhaustion of the lipoid-producing cells would be more rapidly established under the influence of agents which are in a way solvents of such bodies. One of the most interesting thoughts with regard to these observations is the suggestion that the solubility of some of these constituents of cells appears to be much greater during life than postmortem; the abstraction of these agents by known bodies in which they are soluble would seem to be accomplished less rapidly and less effectively from the excised or dead organ than occurs by circulating through the structures media containing anæsthetics or other substances which are solvents for the lipoids. This might be interpreted as indicating that the change was partly metabolic and not purely chemical. If the stage which is now considered dependent upon excitability after the administration of an anæsthetic is really due to the abstraction of pressor substances from the adrenals or other structures then a new point of view is obtained.

ANNUAL ORATION.

Dr. Astley P. C. Ashhurst delivered the Annual Oration entitled "The Patience of Surgery."

BOOK REVIEWS.

DUODENAL ULCER. By B. G. A. MOYNIHAN, M.S., London, F.R.C.S., Senior Assistant Surgeon at Leeds General Infirmary, England. 8vo, 379 pages. Philadelphia and London: W. B. Saunders Company, 1910.

It would seem that during the centuries that have elapsed since human anatomy really began to be studied but little would have remained undiscovered in this particular domain. As a matter of fact, this is not the case, for each new volume that appears contains important discoveries even in the gross anatomy of the body, and the minute anatomy of some of the organs is still a sealed book.

Our knowledge of the appendix and its surgical diseases is relatively recent. All of the abdominal viscera in turn have been subjected to radical operations for the relief and cure of disease and it would seem that little remained to be accomplished.

Within the last year, however, the pancreas and the adjacent hollow viscera have been studied more and more, and it has been the good fortune of the writer of the present volume to elaborate and report a series of clinical studies and operations performed upon the duodenum, which it is safe to say will in the future be regarded as important as the work done in the early eighties by McBurney, Fowler, and other surgeons whose names are especially associated with the operations for appendicitis.

Anatomical knowledge of the duodenum is still far from complete. It is a matter of historic interest that Morgagni described a diverticulum of the duodenum for the first time in 1761, and one or two other specimens were casually reported in the century which followed. The Editor of this journal, Dr. Pilcher, described "A Large Pseudo-diverticulum of the Duodenum" in 1894 and redirected attention to this viscus. In this case the duodenum opened into the sac, and from the sac the jejunum passed. The sac presented mucosa in only one small strip. Elsewhere the parietes were devoid of epithelial lining and exhibited inflammatory changes.

In 1904, Good collected five specimens. Two of these received mere mention. For twenty years few other facts have

been recorded, but within the last year or two, Dr. Wesley M. Baldwin, of the Cornell Medical School at Ithaca, has dissected and demonstrated a remarkable series of cases. As a result of casual findings in the dissecting room, Dr. Baldwin became convinced that diverticula of the duodenum were more common than is generally supposed. He carefully examined the duodenum in 105 consecutive cases, and the result of his investigations showed fifteen true duodenal diverticula. One duodenum presented two diverticula. All of these diverticula were situated upon the left or concave side of the duodenum extending towards the pancreas. Four projected directly into the gland, eight lay behind, while the other three were caudal to the head of the gland. None of the diverticula presented any evidence of inflammatory conditions. All of them belonged to the "true" variety.

Exclusive of this Cornell series, there are reports of only 67 specimens of duodenal diverticula available in medical literature. This figure, however, does not in any way represent the frequency with which these anomalies occur, for, as a matter of fact, the duodenum is rarely carefully examined at the routine autopsy, and still less frequently has it been the subject of surgical intervention.

It is the good fortune of the writer to have seen all of the specimens which Dr. Baldwin has so carefully prepared, and it was evident that many of them, forming pockets within the substance of the pancreas or extending behind the duodenum with an opening often of a size which would barely admit a probe, must be the cause of various disorders of this portion of the intestinal tract not hitherto recognized in a clinical way. The full report of this interesting series will be found in the Anatomical Record in the course of a few months.

This opinion as to the surgical importance of this condition is substantiated by the extraordinary work done by Dr. Moynihan, for there is little doubt that many of the ulcers which he found in his operations started primarily in a duodenal diverticulum.

Ten years ago ulceration of the duodenum was looked upon as a rare disease, and its confident recognition during life was believed to be hardly possible. To-day, largely as a result of Dr. Moynihan's personal observation, it is known to be a common disease and its diagnosis in the majority of cases presents no great difficulties. Indeed, the author states that in his experience, the diagnosis of duodenal ulcer is made with a degree of accuracy that is not exceeded in the case of any other abdominal disorder.

In the book itself the preliminary chapters are devoted to a consideration of the various forms of ulceration of the duodenum. "Curling's ulcer," which often follows extensive burns and scalds of the body, appears to be the most common form due to external traumatism. Uræmia, tuberculosis, or chronic nephritis play an important rôle in the etiology of this affection, and in the newborn, melena neonatorum often arises from ulceration and bleeding from this portion of the bowel. These affections are clearly described but are relatively unimportant when compared with the type of chronic duodenal ulcer which existed in the majority of cases coming under Dr. Moynihan's care.

The symptoms of this type of ulcer are definite; are easily mistaken; and appear in an order and with a precision which are indeed remarkable. Most patients give a clinical history which is of itself of the greatest importance in diagnosis. Physical signs as a rule rarely can be elicited by abdominal palpation. When bleeding occurs as evidenced by hæmatemesis or melena, the prognosis is much more grave than any similar bleeding following ulceration of the stomach. Quite characteristic is the fact that pain, instead of occurring immediately after the ingestion of food, begins three or four hours later at a time when the stomach is practically empty and about the time when the patient begins to feel hungry for his next meal.

The chapter, Symptomatology, is one of the most important in the volume and should enable any one thoroughly familiar with it to make an accurate diagnosis. It is worthy of note that the so-called acid dyspepsia is practically synonymous with this disease, but as a matter of fact, hyperacidity rarely if ever exists. In some aggravated cases which had extended over years, a test of the stomach contents showed little more than half of the normal acidity.

The treatment is essentially surgical in character. No records exist of operations performed after the primary attack, but after the second attack, a number of cases have been operated and the diagnosis confirmed. Four methods of treatment are open to the surgeon: first, excision of the ulcer; second, gastro-enterostomy; third, resection of the duodenum with or without the pyloric portion of the stomach; and fourth, resection and end-to-end anastomosis, the pylorus being left intact. Each of these operations is clearly described, and the illustrations which are well executed add materially to the value of the text.

Perforation is a complication which frequently occurs in the

later stages of the disease, and its possibility should be borne in mind in all cases in which the appendix, the gall-bladder, or the duodenum are objects of suspicion. Even in these severe cases recovery has followed a timely operation. Dr. Moynihan personally reports eleven such cases with but four deaths.

The pathology of duodenal ulcers receives much attention, and in the Appendix there is given a summary of all the cases operated upon by Dr. Moynihan and his associate, Dr. Collinson. For the nine years ending in 1908, 186 cases occurred—males 137, females 49. Eight patients were operated upon twice. The results are truly extraordinary, for up to the end of 1909, the mortality of the whole series was 1.6 per cent., and among the last 121 cases there was no death.

Altogether this volume is one of the most satisfactory to the student, the clinician, or the operating surgeon that has appeared for years, and one which in the future is bound to be the basis for many independent lines of investigation.

HENRY P. DE FOREST, M.D.

THE SURGERY AND PATHOLOGY OF THE THYROID AND PARATHYROID GLANDS. By ALBERT OCHSNER and RALPH L. THOMPSON, St. Louis, C V. Mosby Co., 1910. Octavo, pages 391.

In this book the large clinical experience of the senior author and the special attainments in pathology of the junior author have been combined to present in the most full and satisfactory manner the present knowledge and teachings with reference to the diseases of the thyroid gland. To this has been added the main facts which have been ascertained with regard to the parathyroid glandules.

The book is very freely illustrated, its style is clear, its teachings are plain, and its pages cannot fail to reward either the student or the experienced surgeon who desires to measure his own observations by the standard of others.

The operation of thyroidectomy is minutely described and most elaborately illustrated. This chapter may be considered as presenting in a most satisfactory manner all the elements of the modern methods of removing the diseased thyroid which have been elaborated of late years.

The authors in this book present to us what they consider to be the best, and give their reasons why it is the best. A very considerable part of the book, two-fifths of it, is devoted to the consideration of the parathyroid glandules, the surgical impor-

tance of which, in connection with the results following the removal of the thyroids, has so recently become demonstrated. Present knowledge of these little bodies and all their relations is fully set forth by the authors and adds very materially to the value of the volume as a whole.

THE PRACTICE OF SURGERY. By WALTER SPENCER, M.S., M.B. (London), F.R.C.S. (England), Surgeon and Lecturer Westminster Hospital, and GEORGE E. GASK, F.R.C.S. (England), Assistant Surgeon St. Bartholomew's Hospital. Philadelphia: P. Blakiston's Son & Co., 1910.

The preface heralds the fact that this book is in its tenth edition, a feature in itself to command attention because it attests to the popularity of this "Practice of Surgery" originated by the late W. J. Walsham, of St. Bartholomew's Hospital.

The editors, Messrs. Spencer and Gask, refer to the many courtesies of the collaborators whose contributions have kept this work abreast of the times by the revision and introduction of much that is materially new. Thus a chapter on blood examination, a revision of the section on Ophthalmic and Aural Surgery and many fresh skiagrams are recorded. Likewise emphasized are the additions in orthopædic surgery, the illustrations of museum and histologic specimens, and the drawings bearing on cystoscopy. The chapter on urethritis has been rewritten by Powell.

This book, certainly rejuvenated by these accessions, is in a fair position to gain many adherents among American students of surgery.

Its commendable features are the presence in one volume of general and regional surgery and the most important afflictions of the specialties. The work reflects the teaching of up-to-date surgery and mirrors the practice of the English school.

MARTIN W. WARE.

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